Annual Compliance Report 2024

Banksia Beach Water Treatment Plant & Borefield

EPBC 2007/3396

Revision 1 | November 2024

seqwater
WATER FOR LIFE

Distribution list

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Approved for issue			
Date	**Name**	**Position**	**Signature**
27/11/24	Greg Watkins	Manger Environment	Email approval (internal ref: D24/306719)

Contents

Glossary

Term	Definition
Approval Holder	The person to whom the approval is granted
AWS	Alert Weather Stations
BCAA	Brisbane Caboolture Aquifuture Alliance
BEMP	The Borefield Environmental Management Plan, as required under condition 2 and as amended in accordance with condition 4 or condition 5. The BEMP must include detailed management arrangements for ongoing ecological and groundwater monitoring, and reporting to the Department.
BOMP	The Borefield Operating Management Plan developed to provide early indicators of potential environmental impact through the setting of groundwater level and salinity trigger levels and accompanying management responses
CRG	Community Reference Group
DCCEEW	Department of Climate Change, Energy, the Environment, and Water
Department	The Australian Government Department responsible for administration of the *Environmental Protection and Biodiversity Conservation Act 1999* (Cth)
EPBC Act	*Environmental Protection and Biodiversity Conservation Act 1999* (Cth)
GDE	Groundwater Dependent Ecosystems that are dependent on continuous, seasonal or episodic access to groundwater either after or before it is expressed above the ground surface.
GDU	Groundwater Development Unit refers to Bribie Island's large unconsolidated sand mass aquifers. provided water to the Banksia Beach Water Treatment Plant
Minster	The Minister responsible for administration of the *Environmental Protection and Biodiversity Conservation Act 1999* (Cth)
ML/d	Megalitres per day
MNES	Matters of National Environmental Significance
NDVI	Normalized Difference Vegetation Index
Northern AWS	National Park Alert Weather Stations
Northern Borefield	The area identified as the northern borefield in the BEMP
Northern SMP	Northern Soil Moisture Probe – positioned within the predicted shallow aquifer drawdown zone as the impact site.
QPWS	Queensland Parks and Wildlife Services
Reporting period	1 September 2023 to 31 August 2024
SEQ	South East Queensland
Seqwater	Queensland Bulk Water Supply Authority
SMP	Soil Moisture Probe
Southern SMP	Southern Soil Moisture Probe – positioned outside of the predicted shallow aquifer down zone as the control site.
WTP	Water Treatment Plant

Executive Summary

This Annual Compliance Report summarizes the tenth monitoring period for the Banksia Beach Water Treatment Plant (WTP) and Borefield under the approved Borefield Environmental Management Plan (BEMP), covering 1 September 2023 to 31 August 2024. This report addresses compliance with the conditions set under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) approval 2007/3396.

The BEMP encompasses multiple sub-monitoring programs, including the Aquifer Management Monitoring, Ecological Monitoring, and Meteorological Monitoring Programs. Seqwater has implemented internal procedures and protocols, including the Borefield Operating Management Plan (BOMP) and BEMP to protect sensitive ecological communities and sustainably manage groundwater levels and quality.

Since the Banksia Beach WTP ceased operations in April 2014, no groundwater has been extracted from the borefield. Consequently, the BEMP was revised to reflect a reduced monitoring program for extended shutdown periods (shutdown > 12 months), referred to as cold standby. During cold standby, the Aquifer Management Monitoring Program is suspended, as there is no risk of seawater intrusion or groundwater depletion without extraction. The Ecological Monitoring Program was also refined in 2013 with the specific aim of establishing baseline vegetation conditions and determining the natural variations in vegetation structure, composition, and condition.

For this reporting period, Seqwater engaged an ecological consultant, 3D Environmental, to deliver the *Bribie Island Borefield Groundwater Dependent Ecosystems: Annual Vegetation Monitoring Report 2024* (*Annual Vegetation Monitoring Report 2024*). This report provides a detailed analysis of floristic, soil moisture, and meteorological data to evaluate vegetation conditions and seasonal variations at both sites. The analysis confirms that a predictive ecological baseline has been established based on nine years (2016–2024) of data collected from 18 bi-annual vegetation transect surveys of the 'groundwater-dependent' wet heath community. The extensive dataset significantly improves the ability to predict the potential impacts of groundwater drawdown on the structure and function of groundwater-dependent ecosystems (GDE) and their resilience to climatic disturbances. The *Annual Vegetation Monitoring Report 2024* indicates that minor reductions in groundwater levels from borefield extractions are unlikely to cause any noticeable changes in the ecological state of the vegetation within the drawdown area in the short-term, with detectable impacts possible over decadal cycles. Notably, there is no evidence of ecological lag effects resulting from groundwater abstraction, which ceased in 2014.

Under the BEMP, the Ecological Monitoring Program is only required in cold standby until baseline vegetation conditions are established. Details on this determination are included in this Annual Compliance Report, submitted to the Department of Climate Change, Energy, the Environment, and Water (DCCEEW). With the predictive ecological baseline now established, as confirmed in the *Annual Vegetation Monitoring Report 2024*, Seqwater will suspend the Ecological Monitoring Program at the end of this calendar year. This subcomponent of the BEMP, which includes soil moisture and GDE vegetation monitoring, will conclude, while all other cold standby monitoring activities will continue as required by the BEMP.

During this reporting period, Seqwater did not undertake any activities on Bribie Island that could significantly impact EPBC Act-listed species or Matters of National Environmental Significance (MNES).

Seqwater remains compliant with the EPBC 2007/3396 Conditions as outlined in **Table 4**, with the exception of a partial non-compliance detailed in **Section 4.2** of this report.

1. Introduction

The Queensland Government initiated a series of water infrastructure projects in response to the millennium drought and water supply challenges in South East Queensland (SEQ). In 2006, the *Water Regulation 2002* (Qld) was amended to include bulk water services supply objectives and provisions around Seqwater's water security program, to secure essential drinking water supplies for SEQ in anticipation of growing urban demand. This revision set a target to substitute 10 megalitres per day (ML/d) from the existing water supply system, with water sourced from Bribie Island's deep sand aquifer.

Subsequent aquifer and groundwater modelling studies revealed that sustainable production at the proposed Banksia Beach Water Treatment Plant (WTP) and the existing Woorim WTP was limited to 8 ML/d. Therefore, the proposed extraction rate was formally reduced to 5 ML/d in November 2007. The Banksia Beach WTP was designed for a maximum daily production of 5 ML/d and an annual daily average of 4.32 ML/d, not exceeding 1580 ML/year.

The Banksia Beach WTP and borefield were constructed and commissioned in 2007/2008 by the Brisbane Caboolture Aquifuture Alliance (BCAA). At the same time, the Woorim WTP was decommissioned in 2008 due to infrastructure and water quality issues. The Banksia Beach WTP ceased operations in April 2014 and remains in cold standby (shutdown >12 months).

1.1. Environmental Approvals

The proposed Banksia Beach WTP and borefield project was referred to the Department to determine whether the proposal constituted a controlled action requiring assessment under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act). The Department deemed that the project had the potential to significantly impact Matters of National Environmental Significance (MNES) protected under the EPBC Act; in particular, wetlands of international importance (s 16 and 17(b)). The project was formally declared a controlled action in May 2007 and opened for public comment per EPBC Act s95(a). Commonwealth approval was granted on 7 April 2008 (EPBC 2007/3396).

1.1.1. Environmental Management Plans

Under the approval conditions, the Banksia Beach Borefield Operating Management Plan (BOMP) and the Borefield Environmental Management Plan (BEMP) were implemented to protect ecological communities (e.g., Ramsar Wetland) and manage groundwater. The BEMP aims to ensure the long-term sustainability of the Groundwater Development Unit (GDU) and associated Groundwater Dependent Ecosystems (GDEs). The BEMP contains several monitoring programs, including the Aquifer Management Monitoring Program, the Ecological Monitoring Program, and the Meteorological Monitoring Program.

Following a 3-year detailed review, the Ecological Monitoring Program was refined in 2013 (approved April 2015) with a specific aim to establish baseline vegetation conditions and determine the natural range of variation that occurs across vegetation structure, composition, and condition. Since Seqwater has not extracted groundwater from the Banksia Beach Borefield since the Banksia Beach WTP ceased operations in April 2014, the BEMP was updated again in 2016 to reduce the monitoring program requirements during cold standby. The Aquifer Management Monitoring Program is not required during cold standby as there is no risk of seawater intrusion or groundwater depletion without extraction.

Minor reviews of the BEMP have occurred since, with the most recent amendment to discontinue Normalized Difference Vegetation Index (NDVI) data capture approved by the Department in May 2022.

1.2. Purpose

Under EPBC 2007/3396 Condition 3, Seqwater is required to publish an Annual Compliance Report on its external website addressing the implementation of the BEMP. This Annual Compliance Report, covering the reporting period 1 September 2023 to 31 August 2024, is Seqwater's tenth monitoring period for the Banksia Beach WTP and Borefield under the approved BEMP.

2. Current Status

2.1. Monitoring Requirements

In March 2016, the BEMP was amended to account for the cold standby shutdown (shutdown >12 months), which included:

- Suspending quarterly operational reports;
- Reducing Community Reference Group (CRG) meetings to specific issues;
- Suspending Aquifer Monitoring Program, including Standing Water Level and Electrical Conductivity monitoring;
- Suspending quarterly assessment of meteorological data.

During the 2021-2022 reporting period, the Department approved discontinuing NDVI data capture and analysis. This change was made because NDVI data was found to have no ongoing utility in assessing floristic composition or structural diversity in the wet heath habitats under consideration. **Table 1** details the Ecological Monitoring Program requirements for the current cold standby reporting period, while **Table 2** details the Meteorological Monitoring Program requirements.

Table 1. BEMP Ecological Monitoring Program Requirements During Cold Standby

	Monitoring Type	Frequency (during cold standby)
Ecological Monitoring Program	Vegetation transects surveying at GDE Site 5 (potential drawdown) & GDE Site 6 (control)	Twice yearly – once during the wet season (~March) and once at the end of the dry season (~September). Continue until baseline is established*
	Soil Moisture data collection at GDE Site 5 (potential drawdown) & GDE Site 6 (control)	4 hourly readings taken using a submersible data logger. Continue until baseline is established*

The baseline is set when future differential changes can be statistically evaluated. Once established, it should be included in the Annual Compliance Report, explaining how it was determined. Note: A predictive ecological baseline has been established in this reporting period, see **Section 4.2 for further details.*

Table 2. BEMP Meteorological Monitoring Program Requirements

	Monitoring Location / Data sources	Monitoring Type	Monitoring frequency
Weather Stations	Banksia AWS and Northern AWS	Temperature, Relative Humidity, Rainfall, Wind Speed, Wind Direction	Data compiled monthly
	Bureau of Meteorology (Redcliffe and Beerburrum site)	Temperature, Relative Humidity, Rainfall, Wind Speed, Wind Direction	Recordings can be compiled for reporting via Bureau of Meteorology website

3. Compliance Designation

The compliance designation against each Condition of the EPBC 2007/3396, *Variation to Conditions Attached to Approval* Letter, dated 10/04/2015, for this reporting period is provided in **Table 4**. It includes the compliance designation along with a summary of supporting evidence. Additional compliance details are available in the following sections. A description of the compliance designation terminology used in **Table 4** is provided in **Table 3**. These descriptions have been extracted from the Commonwealth of Australia *Annual Compliance Report Guidelines 2023*.

Table 3. Compliance Designation Terminology Used in Table 4

Compliance Designation Term	Description
Compliant	Achieved when all the requirements of a condition have been met, including the implementation of management plans or other measures required by those conditions.
Partial Non-compliance*	Designated when the requirements of a condition have been undertaken as specified, but minor interruptions occurred due to unforeseen circumstances, such as equipment failures. These interruptions are intermittent and do not substantially compromise the intent or objectives of the condition.
Non-compliant	Designated where the requirements of a condition or elements of a condition, including the implementation of management plans and other measures, have not been met.
Not Applicable	Designated where the requirements of a condition or elements of a condition fall outside of the scope of the current reporting period.

**Designation included after the Department's Environmental Compliance Division advised Seqwater to report monitoring data gaps as partial non-compliance on 23/11/2023.*

4. EPBC 2007/3396 Compliance Table

Table 4. EPBC 2007/3396 Conditions of Compliance Table

Condition Number	Condition	Compliance Designation	Evidence / Comments
1	The **approval holder** must submit for approval by the **Minister** a **BEMP** designed to protect the ecological character of the Moreton Bay Ramsar wetlands. Once approved, the **BEMP** must be implemented. The approved **BEMP** must be published on the **approval holder's** website, with a location and/or metadata that enables easy discovery by relevant web searches, within one month of approval by the **Minister.** The **approval holder** must notify the **Department** within five business days of publishing the BEMP on its website. The BEMP must remain on the website for the period the approval has effect.	☒ **Compliant** ☐ Partial Non-compliance ☐ Non-compliant ☐ Not Applicable	The approved BEMP is available on Seqwater's website: Corporate Publications. See **Section 4.1** for further details.
2	In accordance with the yield identified in the **BEMP,** the **approval holder** must limit groundwater extraction from the **Northern Borefield** to no greater than an annual average of 4.32ML/day, at a maximum daily rate of 5ML/day and totalling no more than 1580ML/year, subject to the requirements of conditions 1, 4 and 5.	☒ **Compliant** ☐ Partial Non-compliance ☐ Non-compliant ☐ Not Applicable	The Banksia Beach WTP has been in cold standby (>12 months) since April 2014, following the BEMP's monitoring and sampling regime. No borefield extraction occurred during this reporting period.
3	The **approval holder** must maintain accurate records of all measures taken to implement the **BEMP** according to the conditions of this approval, and must make these records available to the **Department** on request. Within 3 months of every anniversary of the commencement of the action, the **approval holder** must publish a Compliance Report on its website addressing implementation of the **BEMP.** The **approval holder** must also notify any non-compliance with this approval to the **Department** in writing within 10 business days of becoming aware of the non compliance. The **approval holder** must continue to annually publish the Compliance Report until such time as agreed in writing by	☐ Compliant ☒ **Partial Non-compliance** ☐ Non-compliant ☐ Not Applicable	This Annual Compliance Report satisfies the requirement to annually publish a Compliance Report within 3 months of the September 1 anniversary date. During the preparation of this report, Seqwater became aware of data gaps due to erroneous Soil Moisture Probe (SMP) readings. On 18/11/2024 Seqwater notified the Department of these issues.

	the **Minister.** Such records may be subject to audit by the **Department** or be used to verify compliance with the conditions of the approval.		Further details on the implementation of the BEMP are provided in **Section 4.2**.
4	If the **approval holder** wishes to carry out any activity otherwise than in accordance with the **BEMP,** the person taking the action must submit to the **Department** for the **Minister's** written approval a revised version of the BEMP. The varied activity shall not commence until the **Minister** has approved the revised plan in writing. If the **Minister** approves the revised plan, that plan must be implemented in place of the plan originally approved. All revised plans approved by the **Minister** must be published on the **approval holder's** website within one month of their approval by the **Minister.**	☒ **Compliant** ☐ Partial Non-compliance ☐ Non-compliant ☐ Not Applicable	Following the Department's approval on 20/05/2022, the revised BEMP was implemented, with all active cold standby monitoring activities undertaken during this reporting period.
5	If the **Minister** believes that it is necessary or convenient for the better protection of the relevant matters of environmental significance to do so, the **Minister** may request the **approval holder** to make specific revisions to the **BEMP** and submit the revised plan for the **Minister's** written approval. Once approved, the revised plan must be implemented. Unless the **Minister** has approved the revised plan, the **approval holder** must continue to implement the originally approved **BEMP,** as specified in the conditions.	☐ Compliant ☐ Partial Non-compliance ☐ Non-compliant ☒ **Not Applicable**	No Ministerial requests for BEMP or approval amendments were received during this reporting period.
6	Upon the direction of the **Minister,** the **approval holder** must ensure that an independent audit of compliance with the conditions of approval is conducted and a report submitted to the **Minister.** The independent auditor and audit criteria must be approved by the **Minister** prior to the commencement of the audit. The audit report must address the criteria to the satisfaction of the **Minister.**	☐ Compliant ☐ Partial Non-compliance ☐ Non-compliant ☒ **Not Applicable**	No Ministerial requests for an independent audit were received during this reporting period.

4.1. EPBC 2007/3396 Condition 1

Compliance Designation – Compliant

Following the *Variation to Conditions Attached to Approval* Letter in August 2015, Seqwater promptly implemented the BEMP, which was published on Seqwater's website in September 2015.

The BEMP was later amended in March 2016 to incorporate changes related to the Banksia Beach WTPs cold standby shutdown (>12months). The revised BEMP was published on Seqwater's website in March 2016.

In July 2021, Seqwater requested to remove the annual vegetation change assessment using remote sensing methods (NDVI image capture and analysis) from the approved BEMP. This request was granted by the Department on 20/05/2022 as part of BEMP Revision 13 (13/04/2021). The amended approved BEMP is available on Seqwater's website: Corporate Publications, as required by EPBC 2007/3396 Condition 1.

4.2. EPBC 2007/3396 Condition 3

Compliance Designation – Partial Non-compliance

This Annual Compliance Report, covering the reporting period 1 September 2023 to 31 August 2024, fulfills the requirement under EPBC 2007/3396 Condition 3 to annually publish a Compliance Report within 3 months of the September 1 anniversary date.

During the preparation of this report, Seqwater became aware of data gaps due to erroneous Soil Moisture Probe (SMP) readings. On 18/11/2024, Seqwater notified DCCEEW of these issues, as required under EPBC 2007/3396 Condition 3. Further details on these data gaps are provided in **Section 4.4.2** below. No additional compliance issues arose during this period.

4.2.1. Meteorological Monitoring (BEMP Requirement: Section 7.3)

Under EPBC 2007/3396 Condition 3, Seqwater must maintain accurate records of all measures undertaken to implement the BEMP, including the Meteorological Monitoring Program outlined in BEMP Section 7.3 (see **Table 2**).

Due to severe weather in the summer of 2020-2021, Queensland Parks and Wildlife Services (QPWS) closed the Northern Access Track in January 2022 because of unsafe conditions and coastal erosion. This track provides Seqwater's Hydrometric Team access to the National Park Alert Weather Station (Northern AWS), which records essential climate data for refining and validating groundwater level models. The track reopened in July 2023, allowing the Team to service the Northern AWS on 21/09/2023. However, the inability to perform critical maintenance and calibration of the telemetry infrastructure and monitoring equipment resulted in data validity and reliability issues, especially for the previous 2022-2023 reporting period.

These issues did not recur in this reporting period, with monitoring data from both the Banksia and Northern AWS captured in line with BEMP Meteorological Monitoring Program requirements.

4.2.2. Ecological Monitoring Program (BEMP Requirement: Section 7.2)

Under EPBC 2007/3396 Condition 3, Seqwater must maintain accurate records of all measures undertaken to implement the BEMP, including soil moisture data collection per the Ecological Monitoring Program outlined in BEMP Section 7.2 (see **Table 1**).

The SMPs capture moisture levels at five different depths, collecting data at four-hour intervals over 24 hours. During this reporting period, anomalies were observed at both the Northern (Impact Site) and Southern (Control Site) SMPs:

- **Northern SMPs:** The Northern SMP dataset is missing 260 four-hourly data records over 52 days from September 2023 to August 2024. The missing four-hourly data records represent 2.37% of the total Northern SMP dataset for the reporting period.
- **Southern SMPs:** The Southern SMP dataset is missing 2275 four-hourly data records over 114 days from September 2023 to August 2024 and recorded 2290 individual 'null' readings over 125 days during September and October 2023, and April to August 2024. The missing four-hourly data records represent 20.73% of the total Southern SMP dataset for the reporting period while the 'null' readings represent 20.87%.

The 350mm Northern SMP sensor experienced intermittent failures, rendering data unreliable for this reporting period. Data from the other four depths remained stable and representative. The Northern SMP failures are a reoccurring issue and generally occur at isolated depths, rather than failures across all sensors. The instrument supplier has previously performed remote diagnostics and could not find any sensor or communication faults. After further investigation, it was determined that the likely cause of the intermittent failures is due to air pockets around the probe which results in improper contact with the soil.

As reported in 2022-2023, the 'null' readings caused by air pockets within the soil are beyond Seqwater's control.

Since the Banksia Beach WTP has been non-operational since April 2014 with no borefield extractions, the absence of this data is not expected to impact the long-term understanding of the system. Additionally, following the confirmation of a predictive ecological baseline in the *Bribie Island Borefield Groundwater Dependent Ecosystems: Annual Vegetation Monitoring Report 2024* prepared by 3D Environmental, the Ecological Monitoring Program will be suspended at the end of this calendar year. Further details can be found in **Section 5**.

4.2.3. Annual Vegetation Monitoring Report

Under EPBC 2007/3396 Condition 3, Seqwater must maintain accurate records of all measures undertaken to implement the BEMP, including GDE vegetation monitoring per the Ecological Monitoring Program outlined in BEMP Section 7.2 (see **Table 1**).

Seqwater engaged 3D Environmental, a qualified ecological consultant, to conduct bi-annual vegetation transect surveys at the potential drawdown site (impact plot) and the control site. These surveys informed the preparation of the *Bribie Island Borefield Groundwater Dependent Ecosystems: Annual Vegetation Monitoring Report 2024* (*Annual Vegetation Monitoring Report 2024*), which provides a detailed analysis of floristic, soil moisture, and meteorological data to evaluate vegetation conditions and seasonal variations at both sites.

The *Annual Vegetation Monitoring Report 2024* confirms that a predictive ecological baseline has been established using a comprehensive dataset spanning nine years (2016–2024). This dataset includes structural and floristic data collected through 18 bi-annual vegetation transect surveys of the 'groundwater dependent' wet heath community.

The detailed *Annual Vegetation Monitoring Report 2024* is available in **Appendix A** and the scientific peer review as **Appendix B**. The following key findings are summarised from the *Annual Vegetation Monitoring Report 2024* prepared by 3D Environmental:

- The current dataset captures several climatic drying and wetting cycles, providing valuable insights into potential changes in wet heath community floristic composition and structure due to reduced rainfall and associated soil drying. Importantly, despite groundwater abstraction ceasing in 2014, no evidence of resultant ecological lag effects has been observed. This includes the 2016 monitoring period, which recorded the highest initial species richness and woody stem counts during a long-term wetting trend.

- A clear link between rainfall, soil moisture, and positive impacts on species richness and woody stem counts has been identified, which suggests the establishment of a predictive ecological baseline. This baseline confirms that floristic diversity is strongly influenced by soil moisture, highlighting the potential for water extraction to negatively affect species diversity in the wet heaths of Bribie Island.
- The report indicates that minor reductions in groundwater levels from borefield extractions are unlikely to cause any noticeable changes in the ecological state of the vegetation within the drawdown area in the short-term, with detectable impacts possible over decadal cycles.
- The report concludes that intense wildfires, combined with reduced soil moisture and groundwater availability, exacerbate the severity of wildfire impacts on wet heathlands. Maintaining groundwater levels during drought periods is crucial for preserving the resilience of these communities against severe disturbances such as wildfires.

4.2.4. Community Reference Group

Under BEMP Section 4.2, Community Reference Group (CRG) meetings only occur when specific cold standby shutdown issues arise. No issues were raised by the CRG, nor did CRG meetings occur in this reporting period.

5. Conclusion

Seqwater has not extracted groundwater from the Banksia Beach Borefield since the Banksia Beach WTP ceased operations in April 2014. No activities were undertaken by Seqwater on Bribie Island during this reporting period that could significantly impact EPBC Act-listed species or MNES.

The Banksia Beach WTP has remained in cold standby for more than 10 years, and there are no current plans for reinstatement due to operational constraints, the substantial resources required for operational restoration, and the inability to use the asset for water supply or drought response augmentation. During this reporting period, the WTP's 'keep safe only' maintenance status continued, with additional works undertaken to reduce ongoing maintenance, including electrical and chemical systems isolation.

Based on long-term planning considerations, the WTP's status, and the establishment of a predictive ecological baseline, as confirmed in the *Annual Vegetation Monitoring Report 2024*, the Ecological Monitoring Program will be suspended at the end of this calendar year. This program, a subcomponent of the BEMP, includes soil moisture and GDE vegetation monitoring. Under the BEMP, the Ecological Monitoring Program is only required in cold standby (>12 months shutdown) until baseline vegetation conditions are established. Seqwater will continue all other cold standby monitoring activities in accordance with the BEMP.

Appendix A – Bribie Island Borefield Groundwater Dependent Ecosystems: Annual Vegetation Monitoring Report 2024

Refer to the below *Bribie Island Borefield Groundwater Dependent Ecosystems: Annual Vegetation Monitoring Report 2024* prepared by 3D Environmental.

3D Environmental
Landscape & Vegetation Science

Bribie Island Borefield

Groundwater Dependent Ecosystems -

Annual Vegetation Monitoring Report - 2024

Prepared for Seqwater *by* 3D Environmental

Revision 2 – 25 November 2024

Document Control

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Project Manager: David Stanton
Client: Seqwater
Purpose: Annual vegetation monitoring report for Groundwater Dependent Ecosystems – Bribie Island Borefield – 2024 Monitoring Event

Draft	Date Issued	Issued By	Review	Purpose
Revision 1	18 November 2024	David Stanton		Initial draft
Revision 2	25 November 2024	David Stanton	Ashleigh Muir / Paul Williams	Final document

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Summary

This report represents a compilation and analysis of nine years of intensive data structural and floristic data (2016 to 2024) collected from a 'groundwater dependent' wet heath community (RE 12.2.2) as a component of Seqwater's Annual Compliance Report for the Banksia Beach Borefield. This monitoring fulfills a fundamental requirement of Seqwater's Banksia Beach Borefield Environmental Monitoring Plan (BEMP) and the associated approval under the Commonwealth Environmental Protection and Biodiversity Conservation Act (EPBC Act 1999). Seqwater has not extracted groundwater from the borefield since the Banksia Beach Water Treatment Plant went into Cold Standby in April 2014.

A statistical analysis of the data indicates that the southern 'control or CP' and northern 'impact or IP' sites have similar floristic attributes, with some variation in species composition and structural features, notably stem density. As revealed from on-site soil moisture monitoring stations, the northern impact site is consistently wetter, with more extended periods of soil saturation than the south, which tends to dry more rapidly and to greater depths. The increased wetness may have influenced the slightly higher species richness at the northern site compared to the south in the initial monitoring assessments.

The long-term assessment established a positive correlation between rainfall volume, soil moisture, groundwater, and some shrub species' woody biomass, particularly in the Myrtaceae family, including *Leptospermum semibaccatum* and *Leptospermum polygalifolium.* However, a 2019 wildfire at the impact site overprinted this correlation, influencing shrub population dynamics by stimulating the germination of obligate seeder species, leading to long-term floristic and structural changes in the heathland. There is generally a robust positive correlation between species richness and rainfall, which is strongest where fire is not an influencing factor (i.e., at the unburnt control site). The richness of the forb and shrub lifeforms depends substantially on rainfall and soil moisture availability. In contrast, the richness and cover of sedges/grasses and grasstree are relatively stable regardless of the climatic regime, indicating their morphological plasticity and capacity to cope with both wet and dry conditions.

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The current dataset spans several climatic drying and wetting cycles, providing a valuable database to predict changes to the floristic composition and structure of wet heath communities due to decreased rainfall and an associated drying soil profile. The long-term nature of this assessment suggests that a strong linkage exists between floristic diversity (species number and abundance of key species) and the availability of soil moisture and groundwater. The study established a link between rainfall and soil moisture and its positive influence on woody stem counts for some species and overall species richness, which suggests the establishment of a predictive ecological baseline. Drying of the soil profile occurs naturally during drought conditions. However, this impact on vegetation structure and composition may be compounded by groundwater abstraction, if not carefully managed. Limiting any future groundwater extraction during drought periods will assist in maintaining the resilience of the wet heathland community on Bribie Island and its capacity to withstand severe stochastic disturbances such as wildfire.

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1.0 Introduction

Seqwater engaged 3d Environmental to complete the 2024 bi-annual monitoring event for groundwater-dependent vegetation (otherwise referred to as groundwater-dependent ecosystems or GDEs) at Seqwater's Banksia Beach Borefield and Water Treatment Plant (WTP), located on Bribie Island.

The Banksia Beach WTP has not been operational since April 2014, and no water extraction has occurred. This shutdown in operations has subsequently triggered the cold standby (shutdown > 12 months) reduced monitoring program and sampling regime as outlined within the BEMP, with this assessment forming a component of the Annual Compliance Report, with an initial report issue in December 2015. The BEMP's intent is to address approval conditions under the Commonwealth Environmental Protection and Biodiversity Conservation Act (EPBC Act 1999). This report follows the initial GDE monitoring survey report prepared by Jacobs (2015) for the 2014 – 2015 reporting period and nine subsequent reports prepared by 3d Environmental for 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023 and 2024 reporting periods.

1.1 Previous Work and Assessment Approach

Identifying two terrestrial GDE monitoring locations was an outcome allocated from the Groundwater Model Refinement, GDE Assessment, and Monitoring Review (SKM, 2013). The selection of the monitoring bores considered the following objectives:

- To determine water level patterns of terrestrial vegetation and partition the dominant water source of shallow and deep-rooted vegetation and
- To establish the relationship between seasonal high water tables and water availability for shallow-rooted vegetation.

The location of the northern monitoring site coincides with the area where groundwater modelling has identified the likelihood of groundwater drawdown in the shallow aquifer, referred to as Site 6 or the 'Impact Plots' (IPs 6a - c). The southern monitoring location is approximately 1km south of the northern monitoring location outside the predicted drawdown zone, referred to as Site 5 or the 'Control Plots' (CPs 5a - c). Jacobs (2015) established two transects at each monitoring location (impact and control localities). Subsequently, vegetation surveys were completed in September 2014 and February 2015 to assess the floristic composition and structure of the associated groundwater-dependent vegetation. The timing of the events was to coincide with the latter part of the dry and wet seasons, respectively, to account for seasonal responses in vegetation. An additional transect was added to each site by 3d Environmental in 2016 to increase the quality of the floristic data. Ongoing vegetation monitoring events have occurred after the initial vegetation survey with a specific aim to establish baseline vegetation conditions and determine the natural range of variation that occurs in terms of vegetation structure, composition, and condition. Figure 1 shows the location of the monitoring sites.

1.2 Purpose of Assessment and Scope

The overarching purpose of the Ecological Monitoring Program component of the BEMP is to provide a temporal analysis of natural variations in the coastal heathland's structural and floristic composition. This data collection intends to provide a baseline analysis of the heathland's temporal floristic and structural variability, which can applied to statistically assess differential changes

relating to the impacts of groundwater abstraction on groundwater-dependent vegetation. The scope of the current cold standby Ecological Monitoring Program is to:

1. Undertake field assessment and associated quantitative floristic analysis of the existing vegetation monitoring sites established by Jacobs (2015) and 3d Environmental (2016) utilising methods compatible with previous assessments.
2. Analyse floristic data collected during the current survey with complementary datasets, including Normalised Difference Vegetation Index (NDVI) and Soil Moisture, to determine the vegetation condition at the control and impact sites and assess seasonal variability.
3. Compare previous monitoring survey results, primarily Jacobs (2015) and 3d Environmental (2016, 2017, 2018, 2019, 2020, 2021 & 2022), to assist in characterising the baseline condition of vegetation.

Since 2021, the capture and analysis of NDVI imagery have been excluded from the suite of monitoring parameters due to the lack of any measurable correlation to field-based indices. The amended BEMP and removal of NDVI as a monitoring parameter were approved by the Department of Climate Change, Energy, the Environment and Water (DCCEEW) on 20/05/2022.

1.3 Background and Ecological Context

The monitoring sites coincide with a 'wet heath' community with transects occurring within Regional Ecosystem 12.2.12 (closed heath on seasonally waterlogged sand plains), which has 'least concern' status under Queensland's Vegetation Management Act 1999 and a Biodiversity Status of 'no concern at present.' Regional Ecosystem 12.2.12 spans most of the coastal edge of the Southeast Queensland Bioregion, from Gladstone to the Gold Coast. Heaths are essentially treeless plant communities dominated by low shrubs and other ground flora. Australian heaths are invariably associated with oligotrophic (low nutrient) soils deficient in phosphorus and nitrogen (DERM 2010). Wet heaths rely on shallow groundwater to maintain their unique structure and composition, and the shallow soil profile is likely to be saturated over a considerable proportion of the year.

Knowledge of vegetation dependence on groundwater is relatively undeveloped in the Australian context. Recent studies in coastal heathlands in eastern Australia indicate a need for longer-term monitoring before making any definitive statements on vegetation response to groundwater drawdown (Griffith et al., 2015). Some inferences come from Western Australian examples where monitoring of coastal heath vegetation in the groundwater abstraction area of the Swan Coastal Plain has been continuous for several decades (Froend & Summer, 2010; Froend et al., 2004; Groom, 2004; Groom, 2003; Groom et al., 2001; Groom, 2000). However, the situation on Bribie Island is considerably more dynamic, with higher rainfall and a much shallower groundwater table; therefore, direct comparison may not be possible.

The shallow-rooted heath vegetation on Bribie Island comprises a mix of phreatophytes and facultative phreatophytes (i.e., utilise groundwater but can survive without it). Wet heath vegetation typically has its rooting material, mostly from sedges, herbs, and small shrubs, concentrated in the upper 15cm of soil, the portion of the profile most exposed to periodic wetting and drying cycles in response to rainfall. Several deeper-rooted species, such as *Banksia aemula* and broad-leaf paperbark (*Melaleuca quinquenervia*), can adapt rapidly to changing groundwater levels through accelerated root growth (Griffith et al., 2015). The predicted shallow groundwater level reductions created because of borefield abstraction for both the average and dry weather conditions are minor,

with the maximum predicted drawdown of 0.2 m and 0.3 m, respectively, and drawdown impacts of 0.1 m extending into the eastern Ramsar area towards Welsby and South Welsby lagoons (Seqwater, 2015). Based on Western Australian case studies where groundwater drawdown of several meters over a protracted period was required to elicit a measurable response in vegetation (Groom et al., 2000a, 2000b, Groom 2003, 2004; Froend et al., 2010), the minor reduction in groundwater levels predicted on Bribie is unlikely to promote any noticeable shift in the ecological state of vegetation within the drawdown area in the short term, with detectible impacts possible over decadal cycles. On North Stradbroke Island, a monitoring program between 1988 and 2006 in 18 Mile Swamp demonstrated some vegetation composition and structural changes associated with water extraction (Specht & Stubbs, 2011). They found broad-leaf paperbark trees expanded into the heath and sedgeland areas when water table levels fluctuated in response to drought and water extraction. The paperbarks rapidly grew in height and outcompeted sedges and smaller shrubs, such as the shallow-rooted *Leptospermum juniperinum* (Specht & Stubbs, 2011). This vegetation change has increased the intensity of fires in 18 Mile Swamp, with smouldering bark from paperbarks capable of blowing across fire breaks (Kington et al., 2016).

1.4 August 2019 Fire

A crown scorching fire engulfed an extensive area within the northern portion of Bribie Island National Park, including the Banksia Beach borefield, on 21st August 2019, with approximately 2400 ha of native vegetation combusted. Habitats at Site 5 (Control Site or CPs) were not burnt due to containment lines, though a vast tract of wallum heathland north of Site 5, including Site 6 (impact Site or IPs), was scorched. Visual inspection of the area burnt one month after the passing of the fire indicates that the fire was severe and resulted in the combustion of all living vegetation and nearly all ground fuel, including leaf litter and humous, leaving a scorched ground surface of white sand and fine ash.

Data from the Bribie Island National Park Alert Weather Station (AWS) indicates relative humidity at the time of the wildfire was very low at 16% (Max T°C) with a maximum temperature of 25.9°C and maximum wind velocity of 55.2km/hr blowing from the south-east (129°). The Fire Management System for Bribie Island National Park (QNPWS, 2004) indicates that the North and South monitoring areas burned between 1992 and 1994, with a potential additional burn in 2000. Post-2000 fire history from North Australia and Rangelands Fire Information (NAFI 2023) shows a series of fires on the island between 2010 and 2015, but the subject monitoring areas did not burn. Therefore, before the 2019 wildfire, the study area had been unburned for at least 19 years, possibly up to 25 years. **Figure 2** shows the location of the fire relative to monitoring points.

Figure 1. Location of monitoring transects at the Banksia Beach Borefield.

Figure 2. NDVI imagery showing the extent of fire scarring from September 7 Spot Imagery with delineation between burnt and unburnt vegetation indicated by blue dashed line. The area of red wash indicates living vegetation, noting that monitoring Site 5 has not been burnt.

2.0 Methods

2.1 Field Survey

Timing: Post-wet and dry season monitoring events were completed on 23rd March and 25th October 2024. The post-wet season assessment immediately followed an extended period of climatic drying between January 2023 and December 2023, after which significant rainfall occurred, returning to above-average rainfall conditions before the March 2023 survey. Additional information on climatic conditions before the assessment is provided in **Section 2.3**. The floristic assessment followed a modified version of those documented in Jacobs (2015), adapted from the Queensland CORVEG System (Neldner et al., 2023), assessing vegetation composition and structure.

A central 50m transect marked with star pickets and a 50m tape measure stretched tightly between endpoints formed each survey plot. Extension of the transect 5m on either side of the centreline to provide a 50 m x 10 m plot (0.05ha). Four transects (Plots 5a, 5b, 6a, 6b) were established in September 2014 (each had a third star picket placed at the transect mid-point). Two additional transects (5c and 6c) were established in April 2016 without a central picket. Specific details of data collected at each plot are provided below, with deviations from the methods of Jacobs (2015) identified and discussed in the following sections:

- Canopy intercept of woody species over a measured centre line, from 0 to 50m, separated into:
    - Tree (T1) structural layer being trees > 6m height.
    - Upper shrub (S1) structural layers, being shrubs > 1m height.
    - Lower shrub (S2) structural layers are shrubs in the height range of 0.5 to 1m[1].
    - Ground (G) being all floristic life forms <0.5m height.
- Species richness for all floristic lifeforms within each 0.05 ha plot totaled for the two survey events. The forms allocated in the assessment are:
    - Trees (single stemmed woody plants > 6m).
    - Shrubs (woody multi-stemmed vegetation)
    - Forbs (herbaceous vegetation that is not a grass or other life form)
    - Native perennial grass/sedge/rush (includes graminoids such as sedges, tussock grasses, and restionaceae species. Lomandra spp.[2] have also been included in this category).
    - Grasstree (Xanthorrhoea spp.)[3]
- Counts of woody species within the survey plots within height classes (Trees T1; Shrubs S1 and S2) were an additional parameter added to the survey method in the 2016 monitoring event. Stem counts were completed in a 2m wide belt transect positioned on either side of the centreline tape. This narrow width allows for the accuracy in stem counts required in repeat-measure monitoring surveys.
- Groundcover of floristic lifeforms within 10 x 1m2 quadrats placed at 10m intervals along the tape measure with the initial quadrat position (Q1) at the 4 – 5m interval on the left side and flipped to measure Q2 on the right. The final quadrats, Q9 and Q10, were positioned at

[1] Shrubs in the 0.5 to 1m height range were included in the Ground (G) structural layer in Jacobs 2015.
[2] Included in the shrub category in Jacobs (2015), although the overall cover is shallow.
[3] Not included in the biocondition methodology.

44 – 45m on the left and right sides of the transect, respectively. Cover measurements utilised the Braun-Blanquet method, including % proportions of:

- Native Shrubs < 0.5m. (Specht & Stubbs, 2011).
- Native perennial grass/ sedge/ rush
- Native forbs
- Grasstrees
- Exotic shrubs
- Leaf litter (% of dead leaf matter)
- Bare ground (exposed sand).

- Canopy heights for all canopy intercepts in the T1, S1, and S2 structural layers.

GPS localities of start and end points were recorded in the field, and photographs were taken at the transect centre point from the centre to start, centre to end, centre to the north (right), and centre to the left. Figure 3 shows a generalised plot layout.

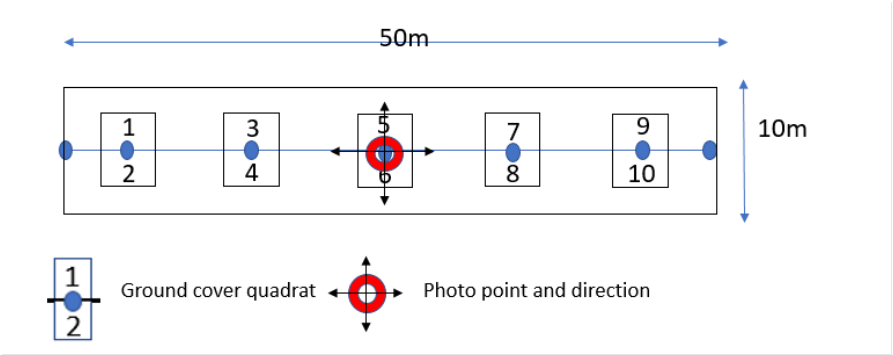


Figure 3. Survey plot layout.

Regarding the assessment of shrub cover, all shrubs >0.5 m in height were attributed to the shrub layer and <0.5m to the ground layer, consistent with methods described in Neldner et al. (2012). Previous surveys by Jacobs (2015) included shrubs <1m height to the ground layer, although this was considered impractical in this assessment due to the strong stratification of other groundcover components into the dense clumping cover typically < 0.5m height.

Six plots were established throughout the survey, with plots 5a, 5b, 6a, and 6b established by Jacobs (2015) in the previous survey event and an additional two sites (5c and 6c) established by 3d Environmental during the 2016 survey event. A summary of all sites is provided in Table 1, and floristic and structural data from all transects are provided in **Appendix A**.

Table 1. Monitoring sites established in the study area.

Transect No.	Purpose of Site	Lat. / Long. Start	Lat. / Long. Centre	Lat. / Long. Finish	Date Established
5a	Control	-26.9942 / 153.1587	-26.9942 / 153.1591	-26.9942 / 153.15932	26 September 2014
5b	Control	-26.9943 / 153.1588	-26.9944 / 153.1590	-26.9944 / 153.15932	26 September 2014
5c	Control	-26.9946 / 153.1588	NA	-26.9944 / 153.15930	4 April 2016
6a	Impact	-26.9856 / 153.1540	-26.9849 / 153.1543	-26.9847 / 153.15449	26 September 2014
6b	Impact	-26.9852 / 153.1542	-26.9852 / 153.15438	-26.9849 / 153.15458	26 September 2014
6c	Impact	-26.9852 / 153.1542	NA	-26.9849 / 153.15458	4 April 2016

2.2 Data Analysis

Field data was entered into structural datasheets and then summarised to allow calculation of total per cent (%) cover of shrub layers, shrub density, and components of the ground cover attributed to growth form, leaf litter and bare ground. **Appendix A** provides data from the two 2024 survey events. The accumulation of large volumes of data with completion of each annual monitoring event has created considerable clutter and complexity associated with data presentation and analysis. To simplify analysis and de-clutter graphs, data collected from monitoring transects at both the control (CPs) and impact sites (IPs) was combined in monitoring periods commencing in the 2021 assessment and continued in the current (2024) assessment, resulting in an overall value score for each of the floristic and structural parameters, applied for data analysis.

ANOVA was used to determine the significance of any differences identified between mean values for structural and floristic features recorded during the data collection process, including the statistical significance of any changes in plant cover and species richness over time. It also allowed an assessment of whether there are consistent differences in any structural group abundance between CPs (5a - c) and IPs (6a - c). Statistical analysis used GraphPad Prism (Version 8.3.2). Tests for normality and lognormality occurred before ANOVA, and a p-value < 0.05 indicated a significant difference in mean values or variance.

For some parameters, Pearson Correlation (*r*) was calculated between datasets to identify correlations and co-dependencies. For correlation assessments, Cumulative Rainfall Departure (CRD) was utilised as a standard variable as this accounted for the cumulative influences of previous climatic regimes, both short-term and long-term. **Section 3.1.1** provides further information on CRD.

2.3 Climate Data

Automated weather stations (AWS) have been used throughout the extended period of the monitoring program to gather information on local rainfall patterns. Seqwater operates and maintains two AWS sites, including the Northern AWS in the Bribie Island National Park and the Southern AWS (or AWS BBWTP) near the Banksia Beach Water Treatment Plant. In recent years, Seqwater have been managing ongoing access and equipment issues with both AWS, particularly the Northern AWS, which is accessible via a track managed by Queensland Parks and Wildlife Services (QPWS). The inability to undertake critical maintenance and calibration of the telemetry infrastructure and monitoring equipment has resulted in some data validity and reliability issues.

The Bribie Island Alert Station (Bureau of Meteorology or 'BOM' Recording Station 040978, located at -27.14, 153.3 in the township of Woorim) has been the primary source of rainfall data applied during this current assessment, and has been collecting local rainfall data since 2006. Although this site is not noted as a data source within the BEMP, presumably this is because it was only available on the BOM Climate Database in 2019, after the implementation of the BEMP. For the purposes of the Ecological Monitoring Program, this site has been deemed a suitable substitute for the assessment of local climate data. Long-term monthly rainfall averages were derived from the Beerburrum State Forest Recording Station (0402284/-26.96, 152.967), a BOM recording station located approximately 10 km west of Bribie Island. Annual rainfall averages for this weather station date back to 1898 and were utilised during climate data analysis to compare local data with long-term regional rainfall trends.

2.4 Soil Moisture Data

Automated soil moisture probes (SMP) were installed at the location of the CPs (5a – 5c) (Southern SMP) and IPs (6a – 6c) (Northern SMP). The SMPs capture moisture levels at five different depths, collecting data at four-hour intervals over a 24-hour period. Soil moisture data provides additional context to interpret changes in vegetation conditions that could be attributed to seasonal cycles of wetting and drying. Sensors were installed to depths of 15cm, 35cm, 65cm, 95cm, and 125cm. The soil moisture logger installed at the northern control site (Northern SMP) was destroyed during the August 2019 wildfire, and due to COVID border restrictions (the consultant is NSW-based), the SMP was not able to be replaced until April 2021. Data outputs from 35 cm and 65 cm sensors at the Northern SMP have been erroneous from the date of instalment in April 2021 to November 2022, when the operation of the 65cm sensor was restored. While Data gaps also occurred in the Southern SMP between 22nd April and 17th August 2021, data recording at this SMP has been otherwise relatively continuous up to the previous September monitoring assessment (Event 16). The 15 and 35cm sensors at the Southern SMP failed on 10th April 2024, reporting mostly null readings from that point forward. The 35cm sensor at the Northern SMP has not recorded data since re-installation. Hence, some significant gaps in soil moisture data are inherent in the current 2024 assessment.

3.0 Results

The assessment results are detailed below, and an analysis of those factors, critical to assessing vegetation condition, structure, and floristic change, is provided. The analysis includes an assessment of the following:

- Climate data.
- Soil moisture data.
- Shrub cover and stem density.
- Groundcover composition.
- Species richness.

The analysis includes comparisons between control and impact sites as well as comparisons between the current and previous survey events back to the 2015 survey period.

3.1 Climate and Soil Moisture

Rainfall and soil moisture data are intimately linked and are dealt with consecutively in this section. As previously discussed in **Sections 2.4** and **2.5**, some datasets needed to be completed and, hence, have not been used in the analysis.

3.1.1 Climate data

Rainfall at the Bribie Alert recording station for 2023 was 875 mm, significantly below the long-term annual average rainfall of 1414.3mm reported from the Beerburrum State Forest (SF). Significant rainfall occurred in December 2023 (176mm), at the commencement of a wetting trend that continued to May 2024, when the Bribie Alert Station recorded 1079mm. For the 10 months of 2024 to the end of October, the Bribie Alert Station recorded 1311 mm of rainfall. This indicates that the dry 2023 was a short-term perturbation before wetter climatic conditions resumed.

The long-term annual rainfall average from the Beerburrum SF is slightly higher than the 30-year average rainfall reported from the Bongaree Bowls Club (near the Bribie Island bridge) of 1211.7mm, extracted from the SILO dataset (SILO 2023), which suggests that the climate of Bribie Island is slightly dryer than the mainland to the west. **Figure 4** compares rainfall trends from both the Bribie Alert and the Beerburrum State Forest recording stations from January 2022 to October 2024**.** Calculation of rainfall mass (Cumulative Rainfall Departure or 'CRD') places rainfall in the context of climatic cycles. CRD was calculated from January 1990 to October 2024 on the SILO climate dataset for Bribie Island (Bongaree Bowls Club), as shown in **Figure 5**. The calculation of CRD subtracts the long-term average monthly rainfall from the actual monthly rainfall and provides a monthly departure from average rainfall conditions (Weber & Stewart, 2004). Shallow aquifers, such as those hosted in the Bribie Island sand mass, tend to follow the same relative patterns regarding depletion and recharge. Between 2000 and 2009, the millennium drought was one of the driest periods recorded. A strongly increasing rainfall trend is evident between 2010 and 2014, with monitoring surveys commencing in 2015 at the initiation of another drying cycle. In the context of broader climatic trends, the GDE surveys have occurred within a drying climatic cycle up to 2019, after which rainfall returned to above-average levels with an associated rise in the rainfall mass curve through December 2022. The dry 2023 is evident on the CRD curve as a short dip before trending toward a much wetter period in 2024. **Figure 5** indicates surveys completed at the Banksia Beach Borefield cover extended wetting and drying climatic cycles. The survey period spans both substantial wetting and drying cycles, which significantly increases the capacity of the surveys to predict the potential impacts of groundwater drawdown on GDE structure and function, as well as their capacity to recover from dryer climatic perturbations. **Table 2** provides CRD values for individual survey events (from 2016) based on climate data dating back to January 1990**.**

Table 2. Monthly CRD values calculated for each individual survey event.

Survey Event	Month / Year	CRD Value (mm)
Event 1	Apr-16	487.6
Event 2	Sep-16	557.4
Event 3	Apr-17	201.4
Event 4	Oct-17	353.4
Event 5	Apr-18	273.7
Event 6	Sep-18	197.2
Event 7	Apr-19	30.3
Event 8	Oct-19	-102.2
Event 9	Apr-20	63.4
Event 10	Nov-20	-108.7
Event 11	May-21	100.6
Event 12	Sep-21	5.9
Event 13	Apr-22	989.4
Event 14	Oct-22	1248.1
Event 15	Mar-23	852.7
Event 16	Sept-23	696.6
Event 17	Mar-24	998.5
Event 18	Oct-24	1017.2

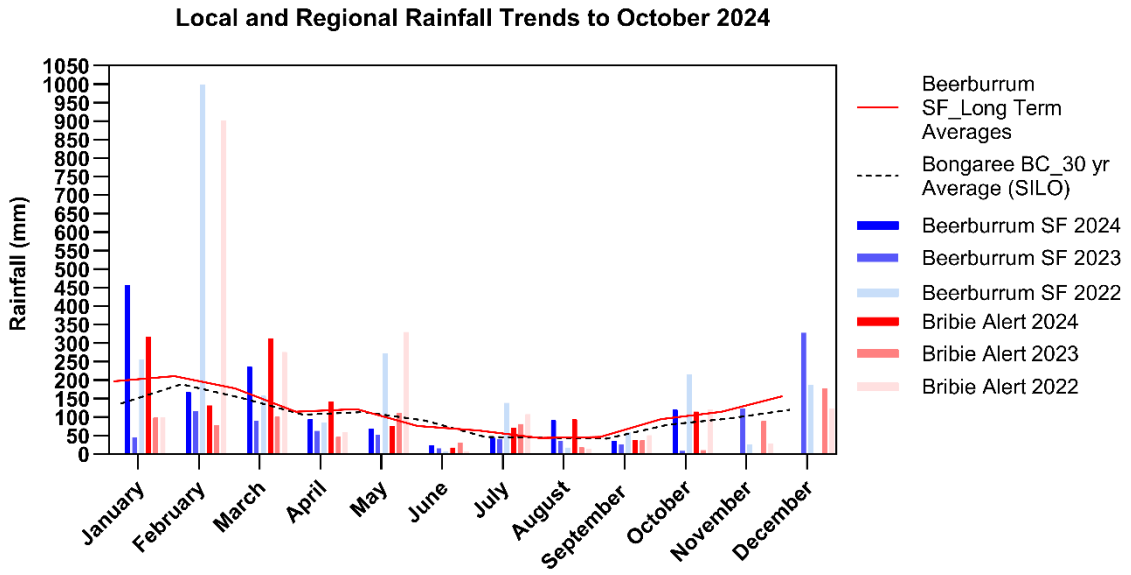


Figure 4. Regional rainfall recorded at Beerburum SF and the Bribie Alert recording stations for January 2022 – October 2024, with long-term average rainfall for the Beerburrum SF and a 30yr average from the Bongaree Bowls Club indicated.

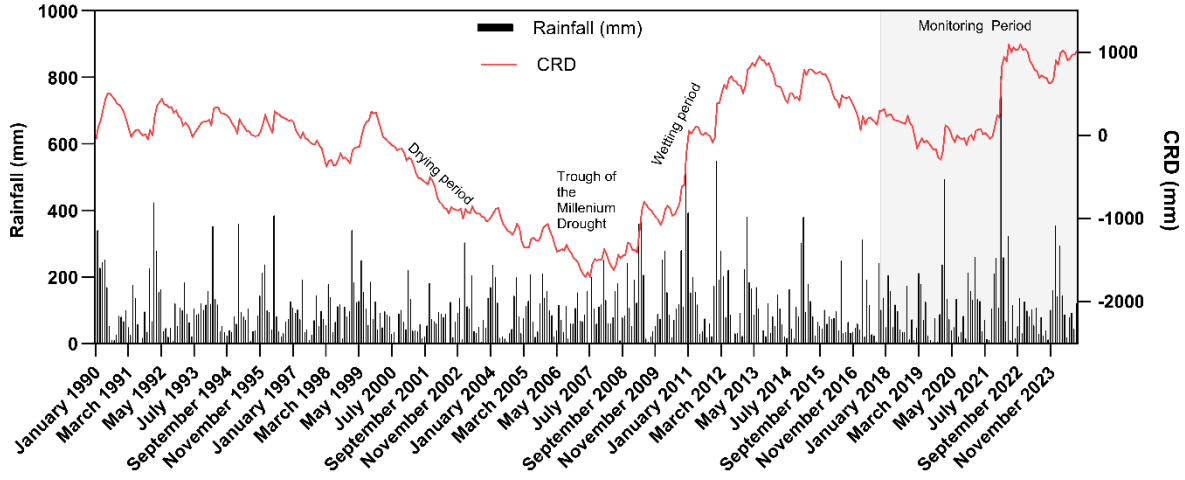


Figure 5. Cumulative rainfall departure calculated for the Bongaree Bowls Club (SILO 2024) with a strong up kick in the rainfall trend indicated in February 2022 associated with an extremely strong rainfall event, a transition into a wetter climatic regime post-2021, and a strong decline in rainfall volumes post December 2022 through to the September 2023 (EV16), and a return to a wetter trend in December 2023.

3.1.2 Soil moisture data

As described in Section 2.4, there are significant data gaps for both the Northern and Southern SMPs for the 2024 assessment period. However, some data from the northern SMP help inform soil moisture trends. Pronounced drying occurred at the 15cm and 65cm sensors at the Northern SMP for the 3-month period from September to 24th December 2023. During this period, moisture at the 65cm sensor fell as low as 6.6 and 12.6% VMC at the 35cm sensor, while the 95cm sensor remained at saturation (33.9% VMC). The 65cm sensor at the Southern SMP also recorded a moisture plunge of similar duration and intensity, falling below 10% VMC for several months and bottoming at 5.9% VMC at its lowest in late December. At 95cm, the soil profile for both the IPs and CPs remained saturated (>34% VMC) throughout the 2024 monitoring period, with only a minor inflection in the Southern SMP, where VMC dropped to 31% for a period of a few days when moisture at the 65cm sensor was at its lowest. From December 2024 onwards, the 15 and 35cm sensors at the Northern SMP were consistently saturated, indicating the groundwater was close to the land surface for entirety of the 2024 monitoring period. Soil moisture trends from January 2021 through to the end of October 2024, covering Survey Event 18, are shown in **Figure 6**.

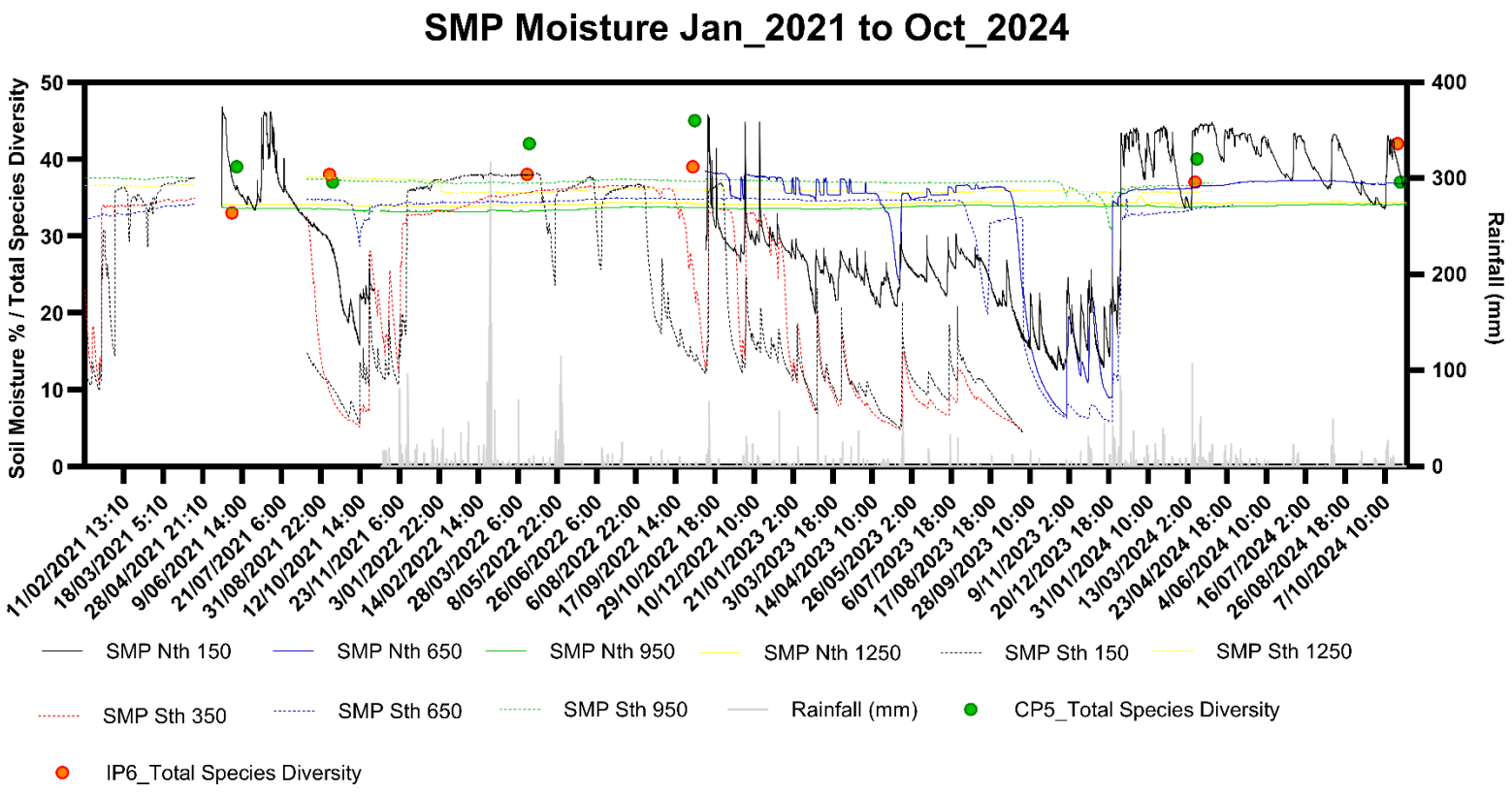


Figure 6. Soil moisture content (VMC%) covering monitoring events from January 2021 to late October 2024 for Southern and Northern SMPs. Significant data gaps are evident in both SMPs, although the data indicates a significant drying of the soil profile in the Northern SMP from September to late December 2023. Species richness recorded during monitoring events is added for context.

3.2 Shrub Cover (%) and Stem Density

Figure 7 shows the average cover values (%) for shrubs >1m in both CPs and IPs. This data indicates that for the CPs, the cover of shrub crowns reached a peak in April 2017 (21.27%) and progressively declined through September 2019 (EV8) before stabilising at 6.4%. From that point, there have been incremental decreases in shrub cover through the remainder of the monitoring period, with EV18 (October 2024) representing the lowest reported value at 4.1%. For the IPs, shrub cover demonstrates an erratic decline from EV1 to May 2019 (EV7), with the destruction of this tallest shrub layer because of the August 2019 wildfire. Following the 2019 wildfire event, cover in the >1m category gradually increased to 17.2% in April 2023 (EV15) before declining in subsequent events, with 14% cover recorded at the end of the monitoring period (EV18), compared to the highest value of 26.67% cover reported in April 2018. Repeat Measures ANOVA indicates that the differences in cover values between survey events are statistically significant for both the CPs ($F_{1.816, 3.633} = 10.70$, $P = 0.031$) and the IPs ($F_{1.622, 3.244} = 12.12$, $P = 0.032$).

Shrub cover values have been more erratic and variable for shrubs in the 0.5m to 1m size classes (see **Figure 8**). For the CPs, the stimulation of the lower shrub layer occurred post-April 2022 (EV13) when cover values began an incremental increase, peaking at 5.7% in April 2023 (EV15), before again declining markedly to the end of the monitoring period at 2.26% (in EV18). The IPs show a similar, though more erratic trend, with shrub cover increasing from 4.6% in April 2020 (EV9) to 14.8% in April 2023 (EV15) before declining substantially to the end of the monitoring period (3.7% in October 2024). While it would be reasonable to attribute the decline in lower shrub layer cover values to shrub migration into a taller size class (i.e., >1m), a commensurate increase in taller shrub cover has not occurred. Hence, the decline is the result of shrub layer attrition rather than shrub advancement. Differences in cover values for the lower shrub layer between monitoring events are not statistically significant for either the CPs ($F_{1.449, 2.898} = 2.764$, $P = 0.27$) or the IPs ($F_{1.989, 3.978} = 1.877$, $P = 0.266$).

Figure 9 indicates IPs have much greater shrub density >0.5m than CPs. April 2016 reported the highest shrub stem at the CPs (EV1 at 210 stems), although this initial value declined rapidly to 46 stems in October 2021 (EV12). Coincident with increasing rainfall volumes, stem counts increased from this event, with 146 stems reported for EV14 and EV15, before declining to 89 stems in October 2024 (EV18). As noted in previous monitoring events and shown in **Figure 10**, *Persoonia virgata* suffered by far the most significant stem count declines in the CPs in the early stage of the monitoring period, and this initially dominant species is now largely absent except for scattered senescing individuals. In the latter monitoring events, increases in shrub density were largely accommodated by *Leptospermum semibaccatum* (**Figure 10**).

Prior to the August 2019 wildfire, stems at the IPs were declining, with a 49.6% reduction between April 2016 (567 stems in EV1) and May 2019 (286 stems in EV7). The declining stem count affected most species except *Persoonia virgata*, whose stem counts were relatively stable in the earlier monitoring events (see **Figure 10**). Following the destruction of woody vegetation by the wildfire in August 2019, a strong rebound in stem densities at the IPs occurred with a consistent increase in counts between monitoring events, peaking with 910 shrubs in September 2023 (EV16), before declining slightly to 802 shrubs in October 2024 (EV18). Accompanying the change in shrub dynamics

at the IPs is a dramatic shift in species composition, with the previously dominant *Persoonia virgata* and *Leptospermum liversidgei* being largely absent from the stem counts, to be replaced by *Phyllota phylicoides* (**Figure 10**). Stanton et al. (2024) suggests that the seedbank of Phyllota survived the wildfire, and stimulation occurred through the double germination trigger of fire and rainfall, while the seed bank of Persoonia perished. *Leptospermum liversidgei* also failed to recruit after the wildfire due to fire-related root bud damage from an intense fire when the soil profile was dry (Stanton et al., 2024). The increase in stem count values at the unburnt CPs in latter monitoring events indicates that wildfire is not the sole influence on woody stem counts and that moisture availability is a likely contributing factor. However, the prolonged absence of fire may be a factor that has also contributed to the senescence of the shrub layer, particularly for obligate seeders such as *Persoonia virgata*.

Pearson Correlation (r^2) indicates no significant correlation exists between rainfall volumes (expressed as CRD) and total stem counts at the CPs (r^2= 0.06544, p=0.306) (see **Figure 11**). For the IPs, there is a robust, statistically significant positive correlation between total stem counts and rainfall volumes (r^2*= 0.775, p<0.0001).* This strong correlation can best be explained by the double germination trigger of fire and increasing rainfall simultaneously stimulating the seed bank. Continuing the trends reported in the EV16 monitoring report, *Leptospermum semibaccatum* demonstrates a strong positive correlation between rainfall volume and woody growth at both the IPs and CPs (*r2 = 0.5869, p<0.0002* for the CPs and *r2= 0.4672, p<0.0018 for the IPs).* The following shrub species also show a strong positive correlation between stem counts and rainfall volume at either the CPs or the IPs:

1. *Pultenaea palacea* (r^2 *= 0.4298, p<0.0031* for the IPs).
2. *Phyllota phylicoides* (r^2 *= 0.6391, p=<0.0001* for the IPs).
3. *Leucopogon leptospermoides* (r^2 *= 0.6231, p=<0.001* for the IPs).
4. *Banksia aemula* (r^2 *= 0.5825, p=0.002* for the IPs).
5. *Banksia oblongifolia* (r^2 *= 0.3791, p=0.007* for the IPs).
6. *Baeckea frutescens* (r^2*= 0.324, p=0.018* for the CPs).
7. *Leptospermum polygalifolium* (r^2*= 0.450, p=0.002* for the CPs).
8. *Homoranthus virgatus* (r^2*= 0.4949; p=0.001* for the CPs).
9. *Melaleuca quinquenervia* (r^2 *= 0.3219; p=0.014* for the CPs).
10. *Strangea linearis* (r^2 *= 0.3335; p=0.012* for the IPs).
11. *Melaleuca pachyphylla* (r^2 = 0.383; p = 0.006 for the CPs).

There have been no substantial changes to these correlations since the prior 2023 monitoring assessment.

Figure 11 (CPs) shows a simple correlation plot between stem counts and rainfall, demonstrating that *Leptospermum semibaccatum* contributes the dominant proportion of recruiting shrubs as the population of *Persoonia virgata has* senesced and that other shrubs demonstrating a positive correlation have relatively low abundance in the total stem counts. The Persoonia population failed to recover after the collapse in EV10 (November 2020), with increasing rainfall in 2021 not influencing recruitment. The drying climate from 2016 to 2019 may have accelerated the collapse of the Persoonia population. However, increasing rainfall will only influence recovery when combined with fire stimulus for this obligate seeder (Stanton et al., 2024). For the IPs shown in **Figure 12**, the

strong statistically significant correlation between rainfall volumes and total stem counts is clear, carrying through to a strong positive correlation between rainfall volume and *Phyllota phylicoides,* which dominate the stem counts. In the absence of additional fire stimulus to germinate the accumulating Phyllota seedbank, the current population is likely to decline into any future monitoring events regardless of rainfall volumes, as the dominance of rainfall-dependent resprouter species such as *Leptospermum semibaccatum, Leptospermum polygalifolium* and *Baeckea frutescens* increases with continuing wet climatic conditions.

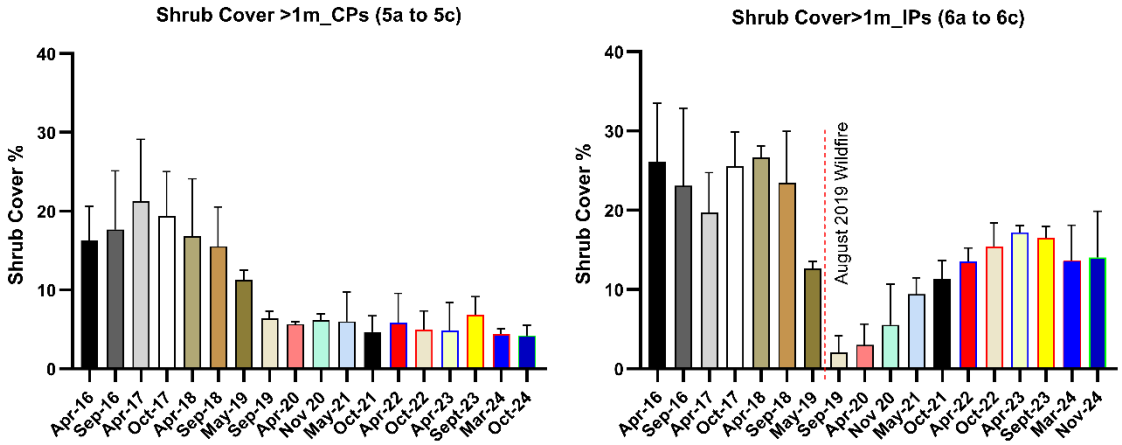


Figure 7. Average shrub cover values in the > 1m size class for the CPs (left) and IPs (right) showing strong declines in cover for both site localities up to May 2019, after shrub cover at the Ips increased significantly after the wildfire.

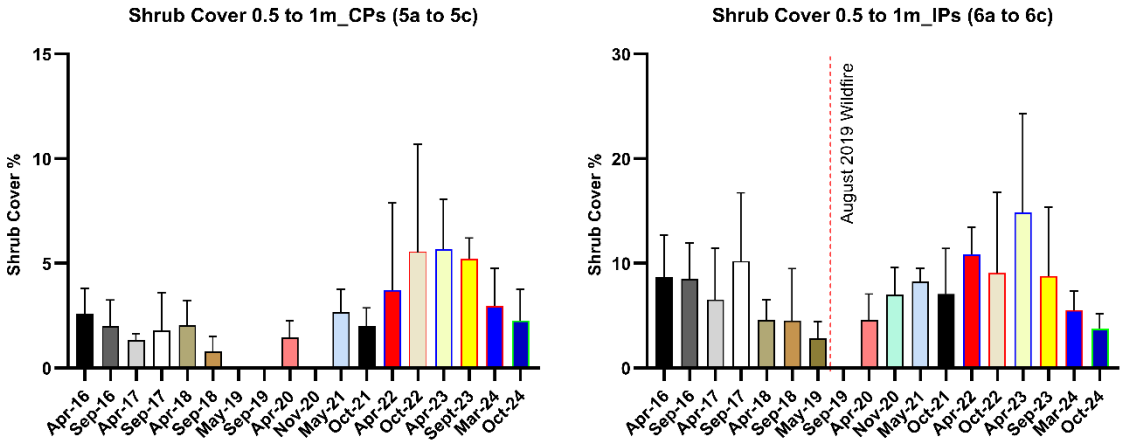


Figure 8. Average shrub cover values in the 0.5 to 1m size class for the CPs (left) and IPs (right) showing variable shrub cover values through to October 2024.

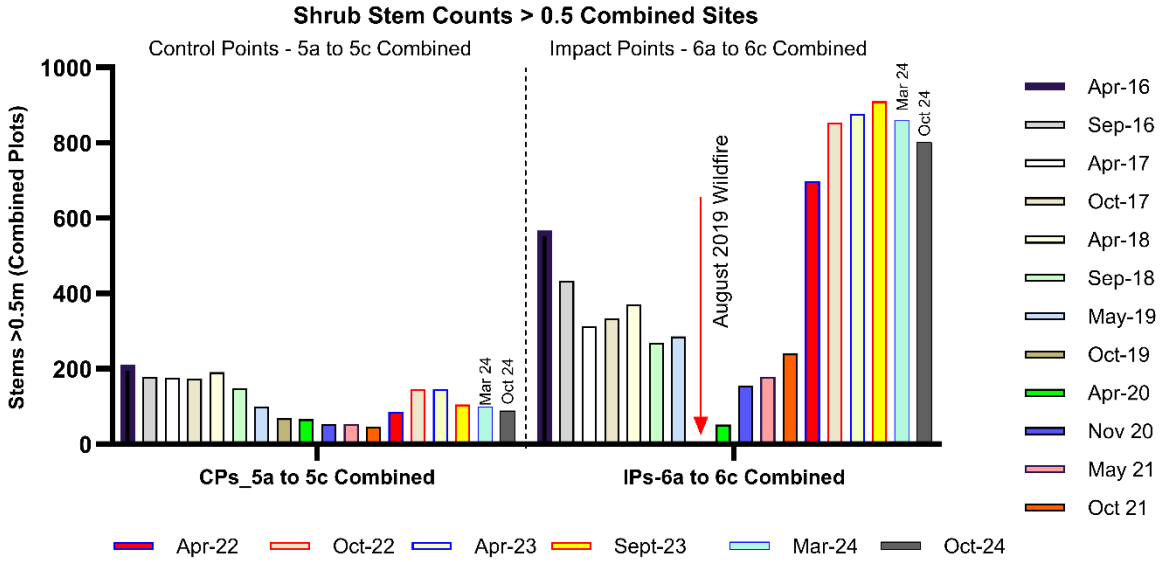


Figure 9. Stem counts for shrubs (> 0.5 m) combining data from individual transects to provide an overall stem count for both the CPs and the IPs (2016 – 2024). The strong rebound in stem counts following the August 2019 wildfire is evident for the IPs with a trend toward increasing stem counts for the CPs evident after the October 2021 assessment. Stem densities declined at both sites in the 2024 assessments.

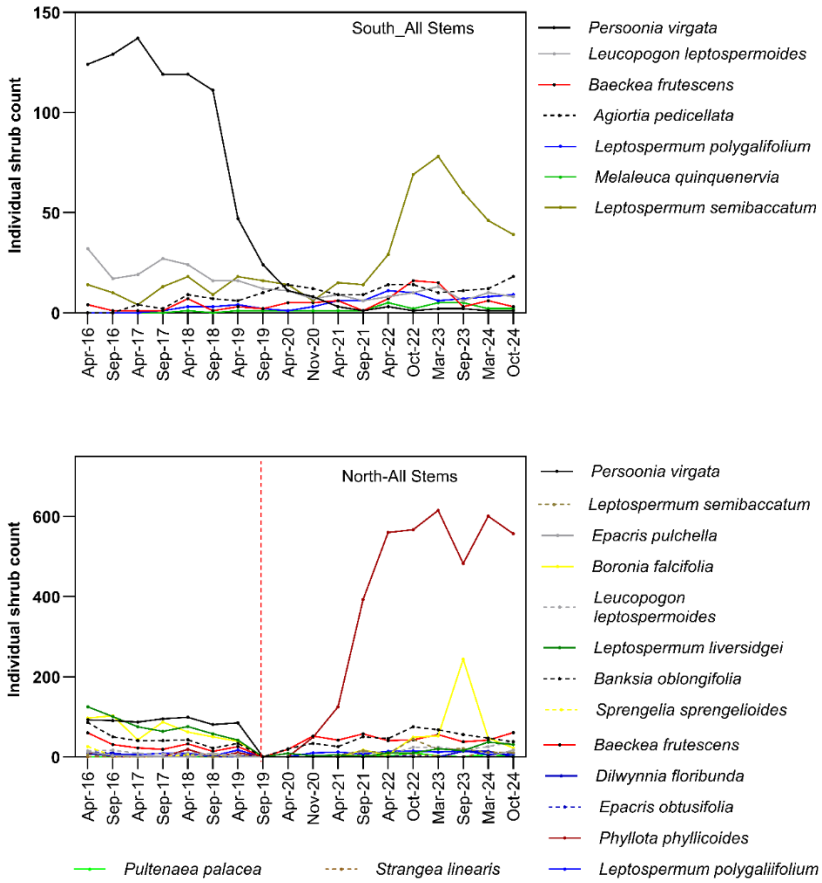


Figure 10. Shrub stem counts for the CPs (top) and IPs (bottom) demonstrating the collapse of *Persoonia virgata* populations at the CPs, offset by an increase in *Leptospermum semibaccatum* stems, and similar collapse of *Persoonia virgata* and *Leptospermum liversidgei* and a massive post-fire increase in *Phyllota phylicoides* stems at the IPs with stabilisation of the population in September 2021.

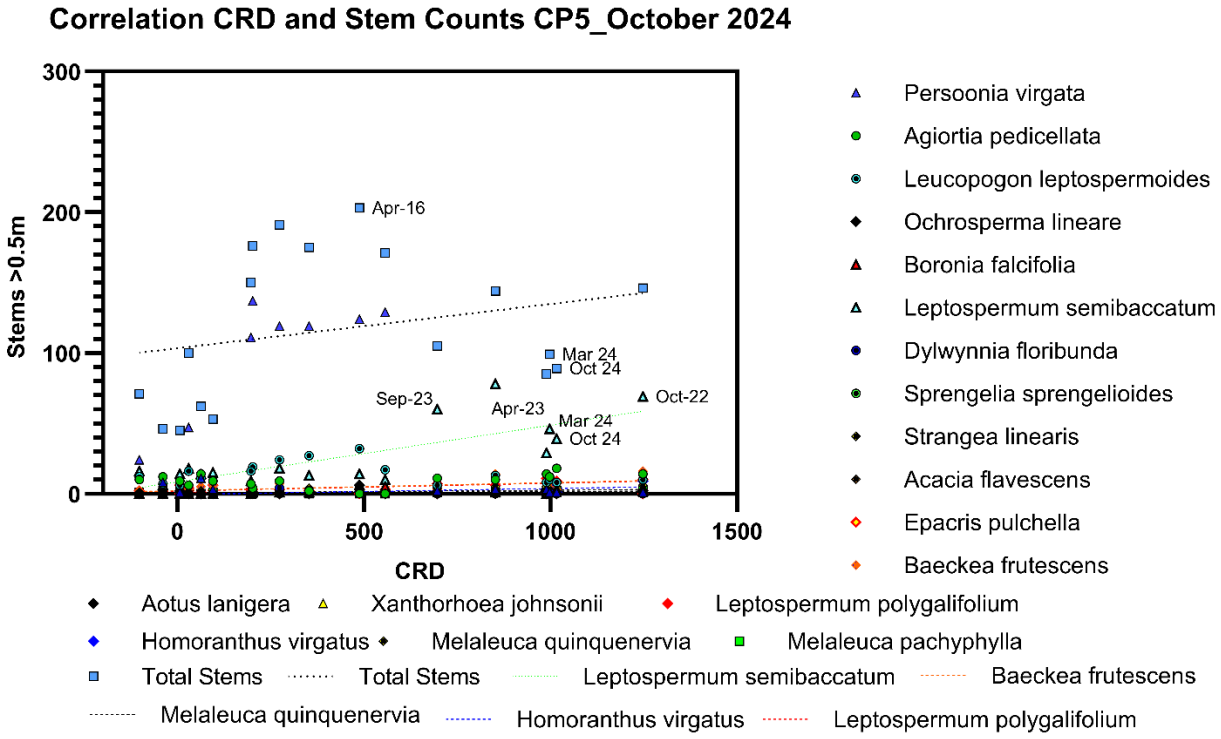


Figure 11. Simple XY correlation between CRD and shrub stem counts (>0.5m) at the CPs showing spike in *Leptospermum semibaccatum* in the 2023 assessment period consistent with CRD trends, and a minor fall in stems in 2024.

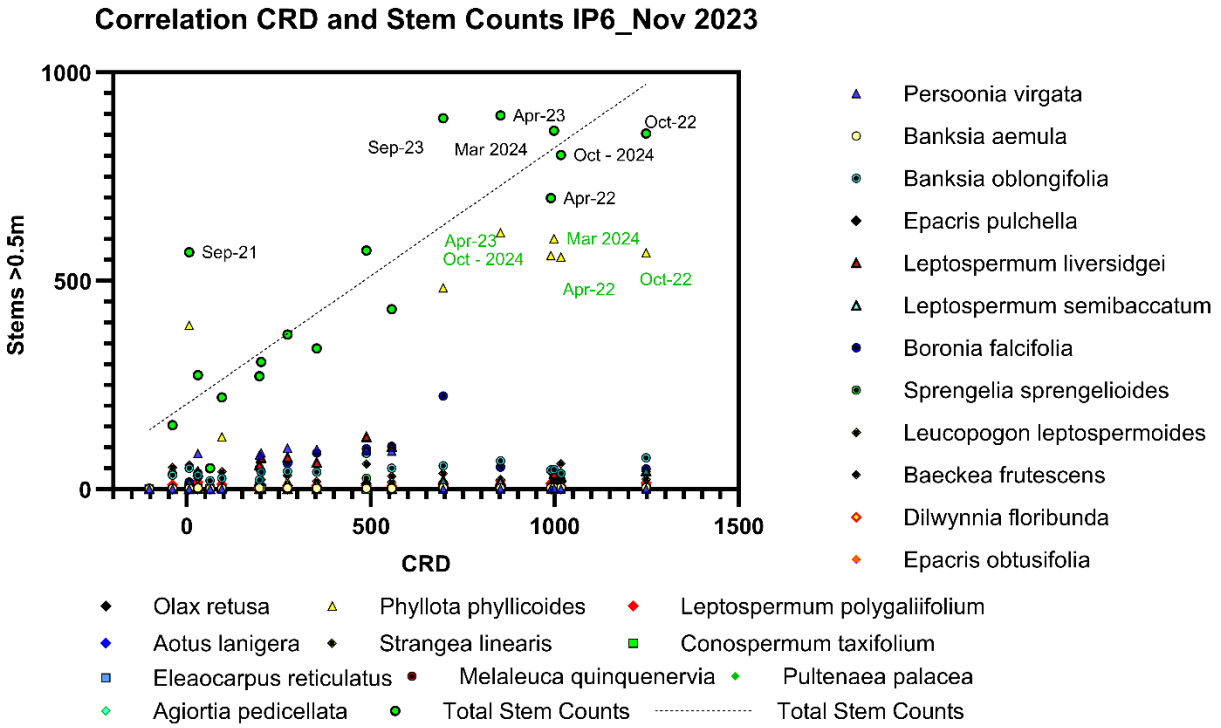


Figure 12. Simple XY correlation between CRD and shrub stem counts (>0.5m) at the IPs showing spike in stem counts dominated by *Phyllota phylicoides* in the post 2022 assessments, consistent with CRD trends.

3.3 Composition and Nature of Groundcovers

Previous monitoring events note sharp and sustained changes in soil moisture for both CPS and IPs in the upper 65cm of the soil profile. These changes include periods when the upper 35cm of the soil profile has dried to < 5% VMC, notably between December 2018 and March 2019, September 2020, January 2021, and more recently from September to December 2023. These drying periods are bridged by wetter periods when soils are saturated to the surface, as occurred throughout most of the 2024 monitoring period. The continuous VMC fluctuations in the shallow soil profile would significantly influence moisture availability for shallow-rooted sedges, forbs, and shrubs that form ground cover components, concentrating rooting matter in the upper 30cm of the soil profile. Sections 3.3.1 to 3.3.6 analyse the structural and floristic trends of groundcover components at each monitoring site. **Table 3** provides a statistical summary of the contributions from various lifeforms made to the groundcover for all monitoring events to EV18 (October 2024).

3.3.1 Native perennial grass / sedge / rush cover

The cover of living grasses, sedges, and rushes has changed subtly at both northern (IP) and southern (CP) sites over the extended monitoring period (see **Figure 13**). However, cover values are at the highest levels reported in the most recent (EV18) assessment. The relative consistency in cover values for sedges and rushes across the broader monitoring period indicates that these lifeforms are morphologically plastic and resilient to pronounced changes in moisture availability. Repeat Measures ANOVA applied to seasonal monitoring data for the southern CPs indicates that changes in native grass, sedge, and rush cover are not statistically significant ($F_{1.621, 3.242} = 4.802$, $p = 0.108$). For the IPs, Repeat Measures ANOVA demonstrates statistically significant differences between monitoring events ($F_{1.848, 3.697} = 11.38$, $p=0.027$), which can be attributed to cover changes initiated by the August 2019 wildfire. After EV18, a weak statistically significant correlation is identified between groundcover sedge/grass/rush values and rainfall volume (CRD) ($r^2 = -0.1772$, $p=0.011$), which suggests that there are likely to be modest increases in sedge/rush cover during extended periods of climatic wetting.

3.3.2 Groundcover shrubs

Although variable between years, native shrubs in the groundcover (< 0.5 m) have generally fluctuated within a consistent cover range between 10.8% and 18.3% for CPs and 15.7% and 26.8% for the IPs. The exception is the post-fire (September 2019) monitoring event, where groundcover shrubs were combusted entirely (see **Figure 14**). Groundcover shrubs were the component that recovered most rapidly from fire disturbance at the IPs, with observations suggesting that this was due to initial rapid nodal re-sprouting of *Baeckea frutescens* and *Banksia oblongifolia*, followed by dense germination of *Phyllota phylicoides*. Repeat Measures ANOVA indicates that the changes to shrub cover values between survey events at the IPs are not statistically significant ($F_{1.439, 2.877} = 7.933$, $P = 0.069$) despite the destruction of shrub cover in the August 2019 wildfire (prior to EV8). For the CPs, shrub cover differences between monitoring events are similarly not statistically significant ($F_{1.754, 3.508} = 1.414$, $p=0.347$). After EV18, there is no correlation between groundcover

shrub values and rainfall volume (CRD) for either the CPs or the IPs (r^2= *-0.0366, p=0.2638*).

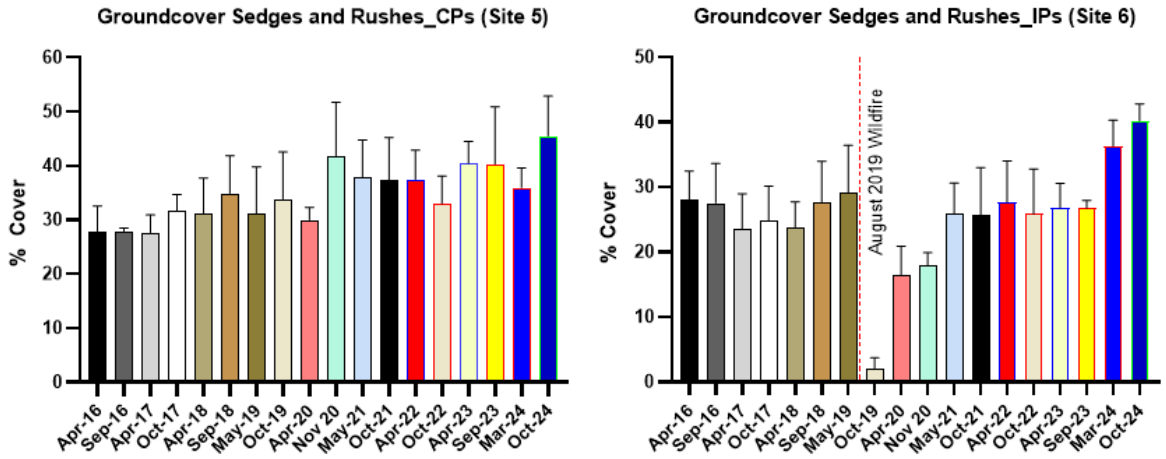


Figure 13. Cover (%) of native grasses, sedges and rushes in the CPs (left) and IPs (right) for all monitoring events.

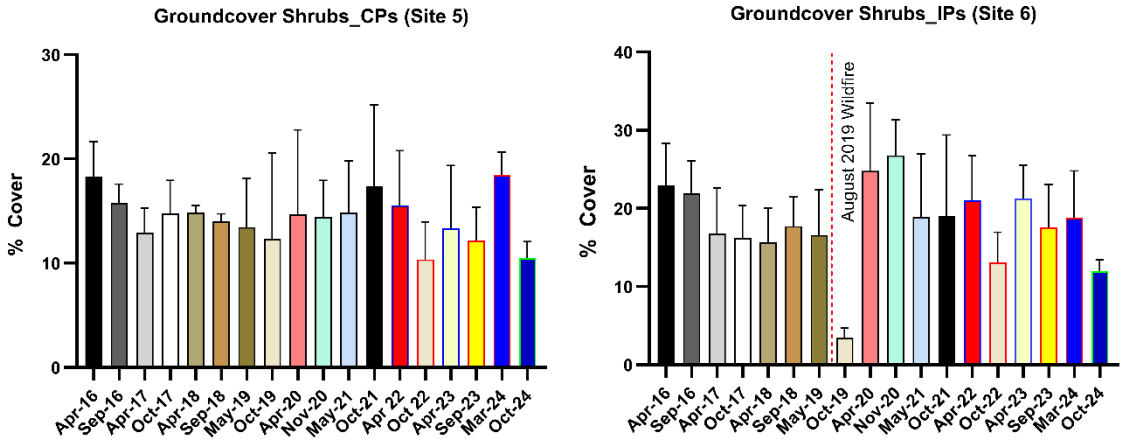


Figure 14. Cover (%) of groundcover shrubs (< 0.5 m) across all sites (2016 – 2024) demonstrating the impact of the 2019 wildfire at the IPs, after which ground cover shrubs recovered to pre-disturbance cover values.

3.3.3 Groundcover forbs

Forbs provide a relatively small contribution to total groundcover values. Due to a general preference for mesic conditions, forbs have relatively low morphological plasticity, which renders them sensitive to droughting. The highest cover of forbs at the CPs was recorded in the April 2022 monitoring assessment (3.02%) when the soil profile had been saturated at the surface for 5 months, although forb cover was relatively low in EV18 (October 2024) at 1.35% cover despite extended wetting. At the IPs, the highest contribution of forbs to total groundcover values was recorded in the October 2021 (EV12) assessment (4.2%). There was another minor spike in forb cover in March 2024 (3.26%), although, after EV18, forb cover was only 1.45%. Generally, for both CPs and IPs, forb cover values are higher in the post-wet assessments than in dry season assessments (**Figure 15**). Repeat Measures ANOVA indicates that despite significant variation in measured forb cover, seasonal variation is not statistically significant for either CPs or IPs ($F_{1.958, 3.917}$ = 5.524, P=0.073 and $F_{1.577, 3.155}$ = 5.925, P=0.09 respectively). After EV18, the groundcover value for forbs strongly correlates to rainfall volumes (CRD) across both the IPs and CPs (r^2 *= 0.3384,*

p=0.0002). **Section 3.3.6** provides further discussion regarding the variation in the diversity and composition of forbs between survey events.

3.3.4 Grasstree cover

Consistent with previous assessments, there are no readily apparent trends with the variability of grasstree cover values seemingly independent of site locality and seasonal survey effort (**Figure 16**). The largest decrease in grasstree cover occurred at the IPs in response to the August 2019 wildfire, although these values rebounded rapidly to post-fire levels by May 2021 indicating the resilience of grasstree to burning through abundant post-fire resprouting from subterranean rhizomes. At completion of EV18, repeat measures ANOVA indicates that the variation in grasstree cover between seasonal monitoring efforts is not statistically significant for either the CPs ($F_{1.786, 3.571}$ =1.883, p=0.273) or the IPs ($F_{1.772, 3.545}$ = 6.616, p=0.647). There is also no correlation identified between grasstree cover values (%) and rainfall volumes (r^2 = -0.554, *p*=0.167).

3.3.5 Total living groundcover

Total living groundcover represents the portion of the groundcover that is living with capacity for photosynthesis and is a possible measure of the health or vigour of a vegetation community at a given point in time. Living groundcover values are balanced by leaf litter and small patches of bare ground (humic sand), which form a component of the ground surface at most sites. Figure 17 provides the proportion (%) for CPs and IPs. Consistent with prior monitoring efforts, subtle cover variations occur between survey events, and the standard deviation of values between monitoring transects remains relatively small without any strong indicators of seasonality. At the completion of the October 2024 assessment, the average living cover value at the CPs was 71.6 %, indicating recovery from the lowest value of 57.75% reported in October 2022 (EV14) at the peak of the climatic wetting trend. At the IPs, total living groundcover was at 71.2%, showing a similar trajectory of recovery as the CPs from the lowest living groundcover value recorded during EV14 (October 2022 at 52.4%), excluding the September 2019 post-wildfire assessment when living groundcover was totally combusted. Repeat Measures ANOVA indicates that the variation in living groundcover between seasonal survey efforts is statistically significant for the IPs ($F_{1.661, 3.322}$ = 22.16, p=0.0125) although not for the CPs ($F_{1.888, 3.776}$ = 2.869, p=0.874). This result would be strongly influenced by the 2019 wildfire event, which completely combusted groundcover at the IPs, creating an anomaly in living groundcover values. At the completion of EV18, no correlation was identified between living groundcover values (%) and rainfall volumes (*r2= 0.062, p=0.143*). As concluded in prior assessments, this suggests that increasing rainfall and moisture availability does not stimulate increased living biomass in the groundcover layers but rather promotes increased vegetation productivity and biomass in the taller woody shrub layers.

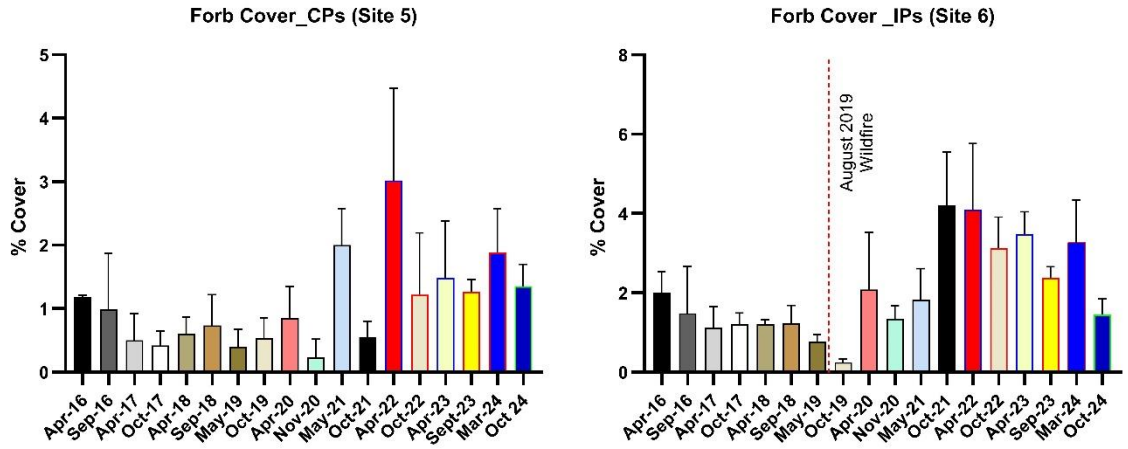


Figure 15. Forb cover (%) across all sites (2016 – 2024) with CPs shown on left, and IPs on right, noting highest forb cover values concentrated in the later monitoring events at both sites, with a decline in forb values in the October 2024 monitoring assessment at the IPs.

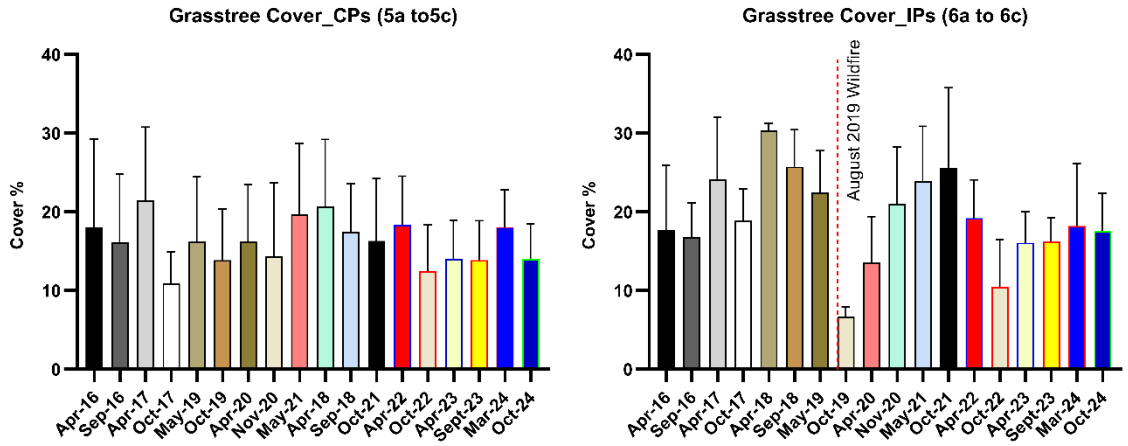


Figure 16. Grasstree groundcover (%) across CPs (left) and IPs (right) for the period from 2016 to 2024.

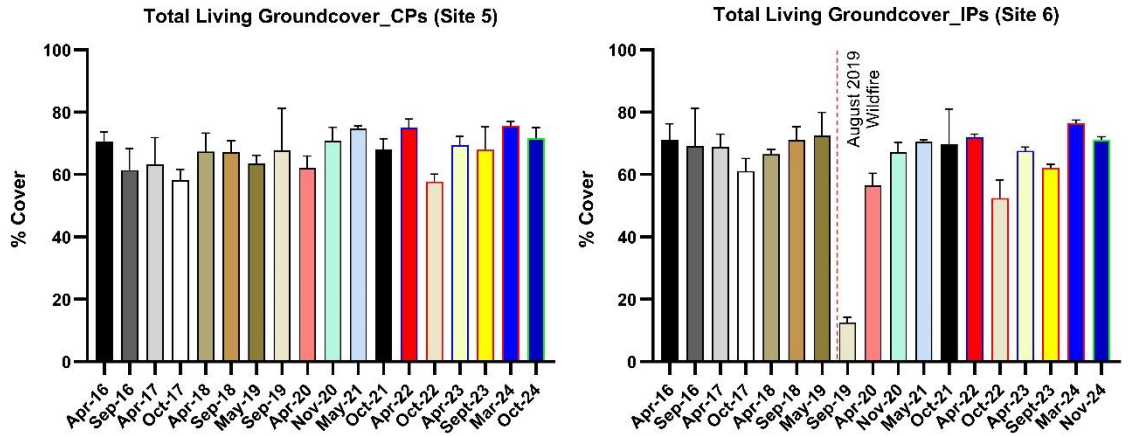


Figure 17. Living groundcover values (%) for CPs (left) and IPs (right) for the period from 2016 to 2024 demonstrating subtle variations in cover values between surveys.

Table 3. Summary of groundcover contribution by various lifeforms over the assessment periods from 2016 to 2024.

Survey Event	Plot Location / Survey Event	Forb % Cover	Sedge / Rush/ Grass % Cover	Shrub % Cover	Grasstree % Cover	Bare % Cover	Leaf % Cover	Exotics % Cover	Cryptogams	Total % Cover	Total Living Cover %
1	Site 5_April 16	0.98	33.63	18.30	17.58	1.62	27.85	0.03	0.00	100	70.50
1	Site 6_April 16	1.75	28.42	25.41	17.67	0.08	26.67	0.00	0.00	100	73.25
2	Site 5_Sept 16	1.18	28.07	15.78	16.08	2.68	35.93	0.27	0.00	100	61.12
2	Site 6_Sept 16	1.97	26.82	21.28	16.17	0.30	33.43	0.03	0.00	100	66.23
3	Site 5_April 17	0.53	28.32	12.92	21.40	0.92	35.91	0.00	0.00	100	63.17
3	Site 6_April 17	0.78	27.53	20.62	18.83	0.00	32.18	0.05	0.00	100	67.77
4	Site 5_Oct 17	0.43	31.90	14.78	10.90	2.65	39.23	0.10	0.00	100	58.02
4	Site 6_Oct 17	1.30	26.48	18.93	16.17	0.83	36.28	0.00	0.00	100	62.88
5	Site 5_April 18	0.60	31.22	14.87	20.67	1.37	31.28	0.00	0.00	100	67.35
5	Site 6_April 18	1.22	23.75	15.68	30.37	0.58	28.40	0.00	0.00	100	71.02
6	Site 5_Sept 18	0.73	34.93	13.98	17.42	3.95	28.95	0.03	0.00	100	67.07
6	Site 6_Sept 18	1.23	27.70	17.70	25.53	2.25	25.58	0.00	0.00	100	72.17
7	Site 5_April 19	0.40	31.12	13.45	18.67	3.10	33.03	0.00	0.23	100	63.87
7	Site 6_April 19	0.77	29.00	16.57	22.42	1.30	29.95	0.00	0.00	100	68.75
8	Site 5_Oct 19	0.43	33.85	12.33	13.83	5.43	33.82	0.13	0.17	100	60.62
8	Site 6_Oct 19	0.25	3.65	3.42	6.65	7.80	78.23	0.00	0.00	100	13.97
9	Site 5_April 20	0.85	30.15	14.67	16.17	14.83	23.10	0.08	0.15	100	61.98
9	Site 6_April 20	2.08	16.38	24.77	13.50	17.43	25.83	0.00	0.00	100	56.73
10	Site 5_Nov 20	0.35	36.65	14.20	17.00	8.92	22.88	0.00	0.00	100	68.20
10	Site 6_Nov 20	1.35	17.97	26.78	21.00	28.75	4.15	0.00	0.00	100	67.10
11	Site 5_April 21	1.97	37.98	14.85	19.67	9.32	15.53	0.10	0.58	100	75.05
11	Site 6_April 21	1.82	22.60	20.67	21.83	18.10	14.98	0.00	0.00	100	66.92
12	Site 5_Oct 21	0.55	37.35	12.37	12.83	9.25	27.53	0.12	0.00	100	63.10
12	Site 6_Oct 21	2.93	20.92	22.82	23.75	19.27	10.32	0.00	0.00	100	70.42
13	Site 5_April 22	3.02	37.48	15.50	18.33	9.48	15.52	0.00	0.67	100	75.00
13	Site 6_April 22	4.10	27.67	21.05	19.17	17.08	10.93	0.00	0.00	100	71.98

Survey Event	Plot Location / Survey Event	Forb % Cover	Sedge / Rush/ Grass % Cover	Shrub % Cover	Grasstree % Cover	Bare % Cover	Leaf % Cover	Exotics % Cover	Cryptogams	Total % Cover	Total Living Cover %
14	Site 5_Oct 22	1.22	33.00	10.37	12.42	27.48	14.77	0.37	0.38	100	57.38
14	Site 6_Oct 22	3.13	25.85	13.03	10.42	21.47	26.10	0.00	0.00	100	52.43
15	Site 5_Apr 23	1.48	40.48	13.37	14.00	8.60	20.33	0.08	1.65	100	70.98
15	Site 6_Apr 23	3.48	26.80	21.22	16.03	7.15	25.32	0.00	0.00	100	67.53
16	Site 5_Sept 23	1.27	40.33	12.15	13.83	7.12	23.98	0.23	1.08	100	68.67
16	Site 6_Sept 23	2.38	26.77	17.58	16.17	1.77	35.33	0.00	0.00	100	62.90
17	Site 5_Mar 24	1.88	35.97	18.43	18.00	7.07	17.13	0.20	1.32	100	75.60
17	Site 6_Mar 24	3.27	36.30	18.73	18.17	2.17	21.37	0.00	0.00	100	76.47
18	Site 5_Oct 24	1.35	45.50	10.48	14.00	8.50	19.65	0.27	0.25	100	71.58
18	Site 6_Oct 24	1.45	40.23	11.98	17.50	0.33	28.50	0.00	0.00	100	71.17

3.3.6 Species richness

Appendix D lists species recorded during the 2024 survey period attributed to individual monitoring sites. Species richness calculations are based on combined data for the three monitoring transects at both the CPs and IPs (i.e., the number of species within 0.15ha). The highest levels of species richness for both the CPs and IPs were reported in the September 2016 survey (**Figure 18**), with 49 and 50 species recorded, respectively. Species richness at the CPs declined from this monitoring event to the 30 species recorded in April 2019, followed by an incremental increase to October 2022, with 45 species reported. Similar trends are reported for the IPs, although species richness was slightly higher in the earlier monitoring events than for the CPs, and the August 2019 wildfire reduced species richness to shallow values (12) in the post-fire October 2019 (EV8) monitoring event. Species richness at the IPs has recovered significantly following the wildfire, primarily driven by increased shrub species since the fire. Data from the 2024 assessment indicates species richness has continued to increase at the IPs from April 2023 (EV15), when 34 species were recorded, to the EV18 assessment, reporting 42 species in October 2024. Species richness totals from the October 2024 (EV18) assessment at the IPs includes *Goodenia stelligera* and *Cryptostylis erecta*, species not previously recorded at the site. In contrast, species richness at the CPs declined in EV18 from 45 species in October 2022 to 28. It is unknown if this result indicates a delayed post-fire rebound in species richness, which will require longer-term monitoring to confirm.

As calculated in prior assessments, there is also a strong positive correlation between species richness and CRD at the CPs (Site 5) (r^2*= 0.4091, p=0.004*) and a moderate (non-significant) positive correlation (r^2 *= 0.163, p=0.097*) for the IPs (Site 6). **Figure 19** demonstrates this correlation with a data outlier evident for the IPs in EV8 due to the wildfire, which would have affected the R2 calculation. As indicated in prior assessments, species richness values from the CPs and IPs form similar trendlines when plotted against CRD, suggesting species richness has a relatively predictable response to changing rainfall volumes, following fluctuations in shallow soil moisture content with species richness increasing during wetter periods and declining as the climate dries.

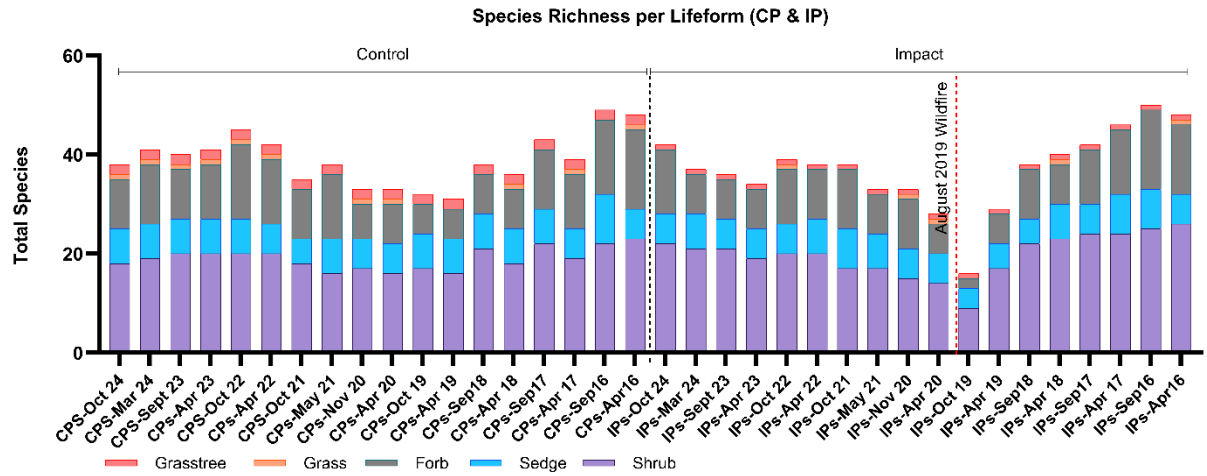


Figure 18. Number of species per lifeform for combined transects from the CPs (Site 5) and IPs (Site 6) up to EV18.

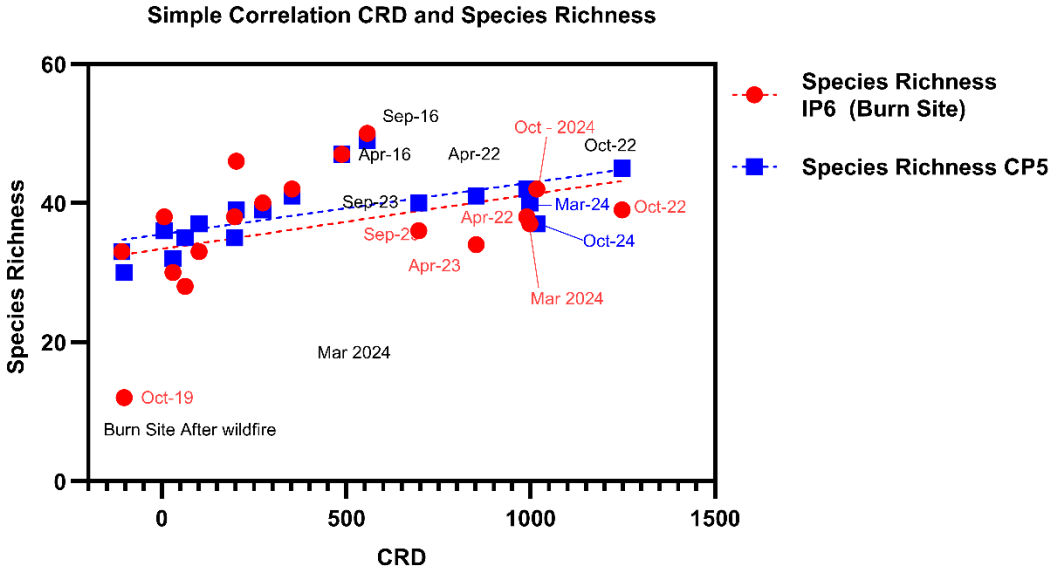


Figure 19. XY correlation plot comparing CRD to species richness for both the CPs (Site 5) and IPs (Site 6) showing the data outlier created by the wildfire (Oct 19 Burn Site after Wildfire) up to the EV18 monitoring event.

4.0 Discussion and Summary

The current assessment forms the 9th year of biannual GDE monitoring at the Banksia Beach Borefield, providing a comprehensive dataset of 18 survey events captured between April 2016 and October 2024. The dataset has been captured over periods of climatic wetting and drying and shows the following major structural and floristic trends:

1. Species richness for both the CPs (Site 5) and IPs (Site 6) remains highest in the September 2016 monitoring assessment, which occurred after multiple wet years. April 2019 (EV7) recorded the lowest species richness value at the CPs, with 31 species reported. The lowest species richness values for the IPs occurred in the October 2019 (EV8) assessment, with 12 species reported immediately following an extreme wildfire event that combusted nearly all living vegetation and leaf litter. The second lowest species richness for IPs was during the dry spell of April 2019, with only 29 species reported before the wildfire. Following the trough in species richness in April and October 2019 for the CPs and IPs, respectively, species richness at both sites increased incrementally to October 2022 (EV14), recording 45 species at the CPs and 39 species reported at the IPs. From this point, species richness has declined at the CPs to 38 species in October 2024, while at the IPs, species richness has increased to 42. It is unknown whether this increase in species richness at the IPs represents a delayed post-fire rebound trend that will continue and whether the reduction in species richness at the CPs indicates floristic stagnation due to an excessively long fire-free interval (> 20 years).

2. After the 2024 monitoring period, statistical analysis indicates a strong correlation between species richness and rainfall volume. The correlation is particularly valid for the CPs, where it is substantial and statistically significant, though less so for the IPs, where a severe wildfire interrupted the trajectory of undisturbed vegetation response. With the decrease in species richness noted at the CPs in the October 2024 assessment relative to the IPs, it is yet to be

determined whether wetting trends will continue to stimulate species richness as the time since fire increases.

3. Groundcover forbs continue to demonstrate a strong and statistically significant positive correlation to rainfall (CRD), while other groundcover lifeforms, including sedges, shrubs, and grasstree, fail to demonstrate any correlation. Total woody shrub counts are not correlated to rainfall volume in the most recent (EV18) monitoring assessment. However, some individual species continue to show a strong and statistically significant positive correlation between shrub density and rainfall volume. Species that demonstrate increased woody biomass (stem counts) in response to wetting trends are typically resprouter species of the Myrtacea family, in particular *Leptospermum semibaccatum, Leptospermum polygalifolium, Homoranthus virgatus,* and *Baeckea frutescens*. During a period of climatic wetting in the absence of fire, these species are expected to increase their respective population sizes while obligate seeder populations will decrease.

4. Additional species continuing to demonstrate a positive correlation to rainfall and associated groundwater and soil moisture include *Pultenaea palacea, Phyllota phylicoides, Leucopogon leptospermoides*, *Banksia aemula*, and Banksia *oblongifolia*. While these species may all be subject to increased woody biomass during wetting trends, obligate seeders such as *Phyllota phylicoides* will ultimately decrease if there is no accompanying germination stimulus to the soil seedbank through fire.

Summary: Ecological data collected over nine survey periods spanning 2016 to 2024 indicates that the CPs and IPs have similar floristic attributes, with some variation in species composition and structural features such as stem density. Before the August 2019 wildfire, stems at the IPs were declining with a 49.6% reduction between April 2016 (567 stems in EV1) and May 2019 (286 stems in EV7), with all species excluding *Persoonia virgata* being affected. Stem counts at the IPs strongly rebounded following the August 2019 wildfire. There was also a substantial shift in species composition, with the previously dominant *Leptospermum liversidgei* reduced to scattered shrubs, and a population of *Persoonia virgata* was eliminated. Species richness also suffered a significant decline. The post-fire peak of 39 species recorded in the EV14 monitoring event is significantly below the initial peak value for species richness reported in EV2 (48 species in September 2016). There is, however, some evidence for a delayed post-fire rebound in species richness at the IPs, with 42 species reported in EV18, including two previously unrecorded species.

At the unburnt CPs, changes in stem count and cover were more subtle with a gradual decline in woody stem mass from EV5 (April 2018) through to EV12 (October 2023) after which stem counts were subject to steady increases through to EV15 (April 2023), again decreasing in the most recent EV18 assessment. Species richness has followed a similar trend with the highest counts in EV2 (49 species), declining gradually through to EV7 (31 species) before a steady rise to EV15 (April 2023) with 45 species and again declining in EV18 (38 species). This may indicate the different dynamics between sites at the CPs compared to the IPs, where stimulation of species richness and woody biomass is through variation in moisture availability alone, and the stimulating impact of fire on obligate seeder populations is not an influencing factor. Structural changes, including increased woody stems of particular Myrtaceae species (including *Leptospermum semibaccatum* and *Leptospermum liversidgei*), are expected during a wetting trend accompanied by an absence of fire.

For species richness, there is also a robust positive correlation between species richness and CRD at the CPs, although this correlation diminishes at the IPs. The lack of correlation between rainfall and species richness is likely an artifact of the wildfire, producing a data outlier that reduced the strength of the positive correlation. Species richness of the forb and shrub lifeforms rely most on rainfall and soil moisture availability. In contrast, the richness and cover of sedges/grasses and grasstree are relatively stable regardless of the climatic regime, indicating their morphological plasticity.

The current dataset spans several climatic drying and wetting cycles, substantially increasing its utility to predict changes to the floristic composition and structure of wet heath communities due to decreased rainfall and an associated drying soil profile. The drying of the soil profile occurs naturally during drought conditions. However, this impact on vegetation structure and composition may be compounded by groundwater abstraction if not carefully managed. Although abstraction from the borefield occurred up to 2014, two years before monitoring began, there is no evidence of resultant ecological lag effects. This considers that the 2016 monitoring period had the highest initial species richness and woody stem counts (at the Southern site), completed at the end of a long-term climatic wetting trend. The dataset has established a link between rainfall and soil moisture and its positive influence on woody stem counts and species richness, suggesting a predictive ecological baseline. The linkage provides evidence that floristic diversity (species number and abundance of key species) is strongly linked to, and increased by, soil moisture, suggesting water extraction could negatively influence species diversity in heaths on Bribie Island. In addition, Stanton et al. (2024) concludes that the compounding impact of intense wildfires and reduced soil moisture and groundwater availability in the rooting zone of wet heathland will significantly influence the severity of a wildfire event. Therefore, limiting groundwater abstraction during drought periods assists in maintaining the resilience of the wet heathland community to severe stochastic disturbances such as wildfire.

5.0 References

3d Environmental (2016). Bribie Island Borefield – Groundwater Dependent Ecosystems Baseline Assessment Report – 2016 Monitoring Event. Prepared for Seqwater.

3d Environmental (2017). Bribie Island Borefield – Groundwater Dependent Ecosystems Baseline Assessment Report – 2017 Monitoring Event. Prepared for Seqwater.

3d Environmental (2018). Bribie Island Borefield – Groundwater Dependent Ecosystems Baseline Assessment Report – 2018 Monitoring Event. Prepared for Seqwater.

3d Environmental (2019). Bribie Island Borefield – Groundwater Dependent Ecosystems Baseline Assessment Report – 2019 Monitoring Event. Prepared for Seqwater.

3d Environmental (2020). Bribie Island Borefield – Groundwater Dependent Ecosystems Baseline Assessment Report – 2020 Monitoring Event. Prepared for Seqwater.

3d Environmental (2021). Bribie Island Borefield – Groundwater Dependent Ecosystems Baseline Assessment Report – 2021 Monitoring Event. Prepared for Seqwater.

3d Environmental (2022). Bribie Island Borefield – Groundwater Dependent Ecosystems Baseline Assessment Report – 2022 Monitoring Event. Prepared for Seqwater.

3d Environmental (2023). Bribie Island Borefield – Groundwater Dependent Ecosystems Baseline Assessment Report – 2023 Monitoring Event. Prepared for Seqwater.

Bureau of Meteorology (BOM) (2022). Climate Data Online – Beerburrum Forest Station, available at: http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=136&p_display_type=dailyDataFile&p_startYear=&p_c=&p_stn_num=040284

Brewer, K. C., Winne, J. C., Redmond, R. L., Opitz, D. W., & Mangrich, M. V. (2005). Classifying and mapping wildfire severity: a comparison of methods. Photogrammetric Engineering and Remote Sensing, 71: 1311–1320.

Enright, Neal & Keith, D. & Clarke, M. & Miller, Ben. (2012). Fire regimes in Australian sclerophyllous shrubby ecosystems: heathlands, heathy woodlands and mallee woodlands. CSIRO Publishing.

Eyre, T.J., Kelly, A.L, Neldner, V.J., Wilson, B.A., Ferguson, D.J., Laidlaw, M.J. and Franks, A.J. (2015). BioCondition: A Condition Assessment Framework for Terrestrial Biodiversity in Queensland. Assessment Manual. Version 2.2. Queensland Herbarium, Department of Science, Information Technology, Innovation and Arts, Brisbane.

Freestone, M., Wills, T., & Read, J. (2015). Post-fire succession during the long-term absence of fire in coastal heathland and a test of the chronosequence survey method. Australian Journal of Botany, 63(7), 572-580.

Froend R., Summer B. (2010). Pheatophytic vegetation response to climatic and abstraction induced groundwater drawdown: Examples of long-term spatial and temporal variability in community response. Ecological Engineering 36; 1191 – 1200.

Froend R, Loomes R, Horwitz P, Bertuch M, Storey A & Bamford M (2004). Study of ecological water requirements on the Gnangara and Jandakot Mounds under section 46 of the Environmental

Protection Act. Task 2: determination of ecological water requirements. Report to the Water and Rivers Commission. Centre for Ecosystem Management, ECU, Joondalup.

Griffith, Stephen J.; Rutherford, Susan; Clarke, Kerri L.; Warwick, Nigel W. M. (2015). Water relations of wallum species in contrasting groundwater habitats of Pleistocene beach ridge barriers on the lower north coast of New South Wales, Australia. Australian Journal of Botany , Volume 63 (7) – Sep

Groom PK, Froend RH, Mattiske EM & Gurner RP (2001). Long-term changes in vigour and distribution of Banksia and Melaleuca overstorey species on the Swan Coastal Plain. Journal of the Royal Society of Western Australia 84 : 63–69.

Groom PK (2003). Groundwater-dependency and water relations of four Myrtaceae shrub species during a prolonged summer drought. Journal of the Royal Society of Western Australia 86 : 31–40.

Groom PK (2004). Rooting depth and plant water relations explain species distribution patterns within a sandplain landscape. Functional Plant Biology 31(5) : 423–428.

Groom PK, Froend RH & Mattiske EM (2000a). Impact of groundwater abstraction on a Banksia woodland, Swan Coastal Plain, Western Australia. Ecological Management and Restoration 1 : 1–12.

Groom PK, Froend RH, Mattiske EM & Koch B (2000b). Myrtaceous shrub species respond to long-term decreasing groundwater levels on the Gnangara Groundwater Mound, northern Swan Coastal Plain. Journal of the Royal Society of Western Australia 83: 75–82.

Groom PK, Froend RH, Mattiske EM & Gurner RP (2001). Long-term changes in vigour and distribution of Banksia and Melaleuca overstorey species on the Swan Coastal Plain. Journal of the Royal Society of Western Australia 84 : 63–69.

Jacobs (2015). Bribie Island Borefield – GDE Heathland Vegetation Monitoring Survey – February 2015. Prepared for Seqwater.

Kington D, Williams P, Collins E, Burns D and Bulley G (2016). Fire Management Strategy for the Indigenous Joint Management Areas (IJMAs) on North Stradbroke Island and Peel Island. Version 2. Queensland Parks and Wildlife Service.

McFarland D. C (1990). Flower and seed phenology of some plants in the subtropical heathlands of Cooloola National Park, Queensland, Australia. Australian Journal of Botany 38: 501 – 9.

Neldner, V.J., Wilson, B.A., Thompson, E.J. and Dillewaard, H.A. (2012). Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland. ISBN: 1-9209280-2-2

Russell, R., Parsons, R., & , (1978). Effects of Time Since Fire on Heath Floristics at Wilson's Promontory, Southern Australia. Australian Journal of Botany, 26(1), 53

Seqwater (2015). Banksia Beach Borefield – Borefeild Environmental Management Plan (BEMP).

SILO (2022) Climate data from Banksia Beach Grid,1990 to 2022 available from: https://www.longpaddock.qld.gov.au/silo/point-data/

SKM (2013) Bribie Island Borefield Groundwater Model Refinement, GDE Assessment and Monitoring Review. Report produced for Seqwater by Sinclair Knight Merz Pty Limited.

Specht, A. and Stubbs, B.J (2011). Long-term monitoring of a coastal sandy freshwater wetland: Eighteen Mile Swamp, North Stradbroke Island, Queensland. Proceedings of the Royal Society Of Queensland 117: 201 - 223.

Stanton D., Dyring M., Proud R., and Williams P. (2024). Wildfire Impact on Coastal Groundwater-Dependent Heathland: Structural and Floristic Responses and Management. Austral Ecology (under review).

Tozer M. G and Bradstock R. A (2002). Fire-mediated effects of overstorey on plant species diversity and abundance in an eastern Australian heath. Plant Ecology: V164, 213 – 223.

6.0 Appendix

Appendix A - Monitoring Transects

Survey Locality 5a

Date of Assessment: 24.03.24 / 24.10.24
Plot Size:50 m linear transect (Canopy Cover); 50 x 4m transect for S2 shrubs >0.5m; 10 x 1m x 1m quadrats for Ground Cover.
Location (Plot Centreline): *Start* -26.9942/ 153.158764; *Centre* --26.9942/ 153.1590571; *Finish* -26.9942/ 153.15932
Structure: Heath

Shrub Cover – Canopy Intercept (>50cm)** (summarised 50 m transect)

March 2024

Intercept (m)	Species	Shrubs > 1m		Shrubs >0.5 to <1m	
		Intercept S1	Height (M)	Intercept S1	Height (M)
12.9 – 14.2	*Agiortia pedicellata*	1.3	1.9		
17.5 – 19.6	*Agiortia pedicellata*	2.1	3		
23.0– 24.8	*Agiortia pedicellata*	1.8	1.8		
26.2 – 27.8	*Leptospermum semibaccatum*			1.6	0.6
36.1 – 36.9	*Leptospermum semibaccatum*			0.8	0.6
37.9 – 39.5	*Leptospermum semibaccatum*			1.5	0.6
Total Cover		**5.2**		**3.9**	
Median Height			**2.0**		**0.6**

* Projected over 100 m; ** Shrubs > 1m

October 2024

Intercept (m)	Species	Shrubs > 1m		Shrubs >0.5 to <1m	
		Intercept S1	Height (M)	Intercept S1	Height (M)
12.4 – 14.2	*Agiortia pedicellata*	1.8	2.0		
17.6 – 19.7	*Agiortia pedicellata*	2.1	3		
22.9 – 24.7	*Agiortia pedicellata*	1.8	1.7		
26.4 – 27.8	*Leptospermum semibaccatum*			1.4	0.8
36.1 – 36.9	*Leptospermum semibaccatum*			0.8	0.6
Total Cover		**5.7**		**2.2**	
Median Height			**2.0**		**0.7**

* Projected over 100 m; ** Shrubs > 1m

Stem Counts (50 x 4) – Shrubs > 0.5m

Species	50 m x 4 m Stems (50x4m) March 2024	50 m x 4 m Stems (50x4m) October 2024
	S2	
Leptospermum semibaccatum	8	6
Dillwynia floribunda	1	
Agiortia pedicellata	7	10

Baeckea frutescens	1	
Leucopogon leptospermoides		3
*Pinus elliottii***		
Melaleuca quinquenervia	1	
Strangea linearis		
Leptospermum polygaliifolium		1
Totals	**18**	**20**

**projected count over 50 x 10m

Ground Cover %- 1 x 1m Sub-plots

March 2024

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean October 2024
Native perennial grass / sedges	*Caustis recurvata*	20		5		5	10	5	20	15	10	**37.8**
	Sporodanthus interuptus	5				5	15	15	30	40	25	
	Lomandra elongata			2	2.5				2.5	2	2	
	Baloskion tenuiculme		30	45	50	5	10					
	Eriachne pallescens var. gracilis			2								
Native forbs and other spp.	*Pimelea liniifolia*	2	1			1		1			2	**1.3**
	Pseudanthus orientalis									1		
	Xyris complanata	1										
	Drosera binata	1		1					1		1	
Native shrubs ,<1m	*Leucopogon leptospermoides*	1				5	5	2.5	20	2.5		**16.35**
	Baeckea imbricata		1	1								
	Baeckea frutescens	2		10						10		
	Strangea linearis		5		2.5	2		2.5			1	
	Leptospermum semibaccatum					15	10	30	20		2	
	Sprengelia sprengelioides		1									
	Ochrosperma lineare		2	2	1	1		1	2.5		2	
	Homoranthus virgatus				1							
Grass Tree	*Xanthorrhoea fulva*	50	10	30	15	40	20	10		15	10	**20**

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean October 2024
Cryptogams		1	1	2	2	1	2	2.5	1	2	2	**1.65**
Bare Ground		2.5	44	0	10	10	5	15	3	2.5	5	**9.7**
Exotic Shrubs	*Pinus elliottii*									1		0.1
Leaf litter		14.5	5		16	10	23	15.5		9	38	13.1
Timber (>/= 10cm)												
Total		**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100%**

October 2024

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean October 2024
Native perennial grass / sedges	*Caustis recurvata*	25	0	50	5	10	15	15	25	10	25	**50.4**
	Sporodanthus interuptus		5	2.5	10	15	10					
	Lomandra elongata		1	10								
	Lomandra longifolia		1	10					1	2.5		
	Eriachne pallescens var. gracilis		1									
	Baloskion tenuiculme	15	30	10	50	15	25	10	30	40	30	
Native forbs and other spp.	*Pimelea liniifolia*	1	2.5		1				1	1	2.5	**1.2**
	Pseudanthus orientalis	1							1			
	Laxmannia gracilis											
	Pattersonia sericea				1							
Native shrubs ,<1m	*Leucopogon leptospermoides*	1					2.5	1	2.5			**8.95**
	Baeckea imbricata											
	Homoranthus virgatus	2.5										
	Strangea linearis		5	2.5	1			1			2.5	
	Leptospermum semibaccatum					5	10	20	15			
	Dilwynnia floribunda											
	Ochrosperma linearis	2.5		5	2.5	1		2.5	2.5	1		
	Acacia bauerii						1					
	Boronia falcifolia											

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean October 2024
Grass Tree	*Xanthorrhoea fulva*	30	10		10	25	20	5		15	10	**12.5**
Cryptogams												**0**
Bare Ground		5	10	5	10	15	0	30	10	5	10	**10**
Exotic Shrubs	*Pinus elliottii*				1							0.1
Leaf litter		17	34.5	5	8.5	14	16.5	15.5	12	25.5	20	16.85
Timber (>/= 10cm)												
Total		**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100%**

Additional Species (50 x 50m plot) recorded in May and Oct 2024ember surveys:

Burchardia umbellata , Patersonia sericea, Epacris obtusifolia, Mirbellia rubiifolia, Boronia falcifolia, Eriachne pallescens

Structural / Floristic Summary

BioCondition Attribute		March 2024	Oct 2024
Native Plant Species Richness	Tree:		
	Shrub:	11	11
	Grass Tree	2	2
	Grass / Sedge / Rush	5	5
	Forbs and other:	6	5
Total Species No.**		**27**	
Native Shrubs	Projected Canopy Cover – Shrubs > 1m (%)	5.2	5.7
	Projected Canopy Cover – Shrubs >0.5 to <1m (%)	3.9	2.2
	Median Height >1m	2.0	2.1
Native Ground cover (%):	Native perennial grass / sedge cover (%):	37.8	50.4
	Native shrubs (%)	16.35	8.95
	Grass tree	20	12.5
	Organic litter cover (%):	13.1	22.9
	Native forb cover	1.3	1.2
Coarse woody debris:	Total length (m) of debris ≥ 10cm diameter and ≥0.5m in length per hectare	0	0
Non-native plant cover	Non-native Grasses	0	0
	Non-native shrubs	0.1	0.1

****Excludes Exotic Species**

Plot 5a – Centre to Start; March 2024 (Above) and October 2024 (below).

Plot 5a – Centre to End; March 2024 (Above) and October 2024 (below).

Plot 5a – Centre to North; March 2024 (Above) and October 2024 (below).

Plot 5a – Centre to South: March 2024 (Above) and October 2024 (below).

Survey Locality 5b

Date of Assessment: 24.03.24 / 24.10.24
Plot Size:50 m linear transect (Canopy Cover); 50 x 4m transect for S2 shrubs >0.5m; 10 x 1m x 1m quadrats for Ground Cover.
Location (Plot Centreline): *Start* -26.9943/ 153.1587965; *Centre -26.9944*/ 153.1589816; *Finish* -26.9944/ 153.1593191
Structure: Heath

Shrub Cover – Canopy Intercept (>50cm)** (summarised 50 m transect)

March 2024

Intercept (m)	Species	Shrubs > 1m		Shrubs >0.5 to <1m	
		Intercept S1	Height (M)	Intercept S1	Height (M)
17.2 – 18.5	*Xanthorrhoea johnsonii*			1.3	0.9
19.7 – 19.8	*Leucopogon leptospermoides*			0.6	0.6
22.8 – 23.3	*Leucopogon leptospermoides*			0.5	0.6
25.1 – 26.2	*Leptospermum semibaccatum*			1.1	0.5
31.4 – 31.8	*Leucopogon leptospermoides*			0.4	0.5
46.2 – 46.4	*Leptospermum semibaccatum*			0.2	0.5
Total Cover				**4.1**	
Median Height					**0.7**

** Shrubs > 1m

October 2024

Intercept (m)	Species	Shrubs > 1m		Shrubs >0.5 to <1m	
		Intercept S1	Height (M)	Intercept S1	Height (M)
17.7 – 18.4	*Xanthorrhoea johnsonni*			0.7	0.7
19.7 – 20.3	*Leptospermum semibaccatum*			0.6	0.6
20.5 – 21.3	*Leptospermum semibaccatum*			0.8	0.8
25.0 – 25.4	*Leptospermum semibaccatum*			0.4	0.6
30.8 – 31.4	*Leptospermum semibaccatum*			0.6	0.55
31.5 – 32.2	*Leptospermum semibaccatum*			0.7	0.6
Total Cover				**3.8**	
Median Height					**0.6**

** Shrubs > 1m

Stem Counts (50 x 4) – Shrubs > 0.5m

Species	50 m x 4 m Stems (50x4m) March 2024	50 m x 4 m Stems (50x4m) October 2024
	S2	S2
Persoonia virgata	1	1
Leucopogon leptospermoides	8	2
Ochrosperma lineare		
Boronia		
Leptospermum semibaccatum	23	25
Sprengelia sprengelioides		
Strangea linearis	2	
Acacia flavescens	1	1

Species	50 m x 4 m Stems (50x4m) March 2024	50 m x 4 m Stems (50x4m) October 2024
	S2	**S2**
Epacris pulchella		
Agiortia pedicellata	3	5
Baeckea frutescens	1	
Xanthorrhoea johnsoni (from top of trunk	1	1
Boronia falsifolia	1	2
Leptospermum polygaliifolium	1	1
Totals	**42**	**39**

**projected count over 50 x 10m *Exotic species not counted in stem counts

Ground Cover %- 1 x 1m Sub-plots

March 2024

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean Mar. 2024
Native perennial grass / sedges	*Caustis recurvata*	25	5	10	25	10	10	5	5	20	20	
	Sporodanthus interuptus	15	20	10		25	25	5	0	0	5	
	Baloskion tenuiculme		10	10			20	20	30	20	15	
	Lomandra elongata	2	2.5				1	1				**38.35**
	Lomandra sp.				2.5							
	Eriachne pallescens var. gracilis											
	Hypolaena fastigiata				2.5	1	2		1	1	2	
Native forbs and other spp.	*Pimelea liniifolia*	1	1	1		1	1	1	1			
	Cassytha glabella					2.5						
	Patersonia sericea		5	2								
	Laxmannia gracilis											**2.65**
	Drosera binnata	1	1	1	1	1		1	1	1	1	
	Pseudanthus orientalis				1							
Native shrubs ,<1m	*Leucopogon leptospermoides*	5	2			5		20	5	1	2	
	Strangea linearis			1	5	1	2	5	1			
	Epacris pulchella											**20.8**
	Leptospermum semibaccatum			25	30	15	25	5	10	1	2	
	Dilwynnia floribunda				1		1			2.5		
	Homoranthus virgatus	1										

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean Mar. 2024
	Baeckea frutescens							5	1	2.5	2	
	Olax retusa											
	Ochrosperma lineare	1		2	1	2	2.5	1	2	2		
	Acacia baueri			1				1	1			
	Baeckea imbricata								1			
	Spengelia sprengelioides				1		1					
	Persoonia virgata				1		2.5		1			
Grass Tree	*Xanthorrhoea fulva*	30	5	30		10		10	5	25	10	**12.5**
Cryptogams		2		2	2.5	2	2	1	2.5			**1.4**
Bare Ground		5	10	5	5	10	5	5	5	2.5	2.5	**5.5**
Exotic Shrubs	*Pinus elliottii***		1			1		1			1	**0.4**
Leaf litter		12	37.5	0	21.5	13.5	0	13	27.5	21.5	37.5	**18.4**
Timber (>/= 10cm)												
Total		**100 %**	**100 %**	**100 %**	**100 %**	**100 %**	**100 %**	**100 %**	**100 %**	**100 %**	**100 %**	**100%**

Additional Species: *Dillwynia floribunda. Boronia*

October 2024

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean October 2024
Native perennial grass / sedges	*Caustis recurvata*	20	5	10	25	10	15	10	15	15	20	**49.1**
	Sporodanthus interuptus	15		2.5	10	5	10	5	10	5	5	
	Baloskion tenuiculme	30	60	5	25	10	10	20	15	20	25	
	Lomandra elongata		5	5			2.5	2.5		5		
	Schoenus calostachys											
	Hypolaena fastigiata			2.5	2		4	2.5	1	2.5	2.5	
Native forbs and other spp.	*Pimelea liniifolia*	1	1	1	1			1				**1.75**
	Cassytha glabella								1			
	Pattersonia sericea		5									
	Laxmannia compacta					1	1					

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean October 2024
	Fern			1								
Native shrubs ,<1m	*Leucopogon leptospermoides*	5			10		20	1		10	2.5	
	Strangea linearis	1	2.5	2.5	1	10		5	1		2.5	
	Leptospermum semibaccatum		5			5		30	10		2.5	
	Dylwynnia floribunda	1	1			2.5				1	1	
	Homoranthus virgatus	1		1	2				5			**12.1**
	Olax retusa	1										
	Ochrosperma lineare				1	2.5	1	1		2.5	2.5	
	Sprengellia sprengelioides					1	1					
	Acacia baueri				2							
Grass Tree	*Xanthorrhoea fulva*	20	5	25		5			10	15	10	**10.5**
Cryptogams				10	5	5	5	2.5	2.5			**0.75**
Bare Ground			5	10	10	10	5	5	5	5		**7.25**
Exotic Shrubs	*Pinus elliottii***	1	1						1	1		**0.7**
Leaf litter		4	4.5	24.5	6	33	25.5	14.5	23.5	18	26.5	**17.85**
Timber (>/= 10cm)												
Total		**100 %**	**10 0%**	**100 %**	**100 %**	**100 %**	**100 %**	**100 %**	**100 %**	**100 %**	**100 %**	**100%**

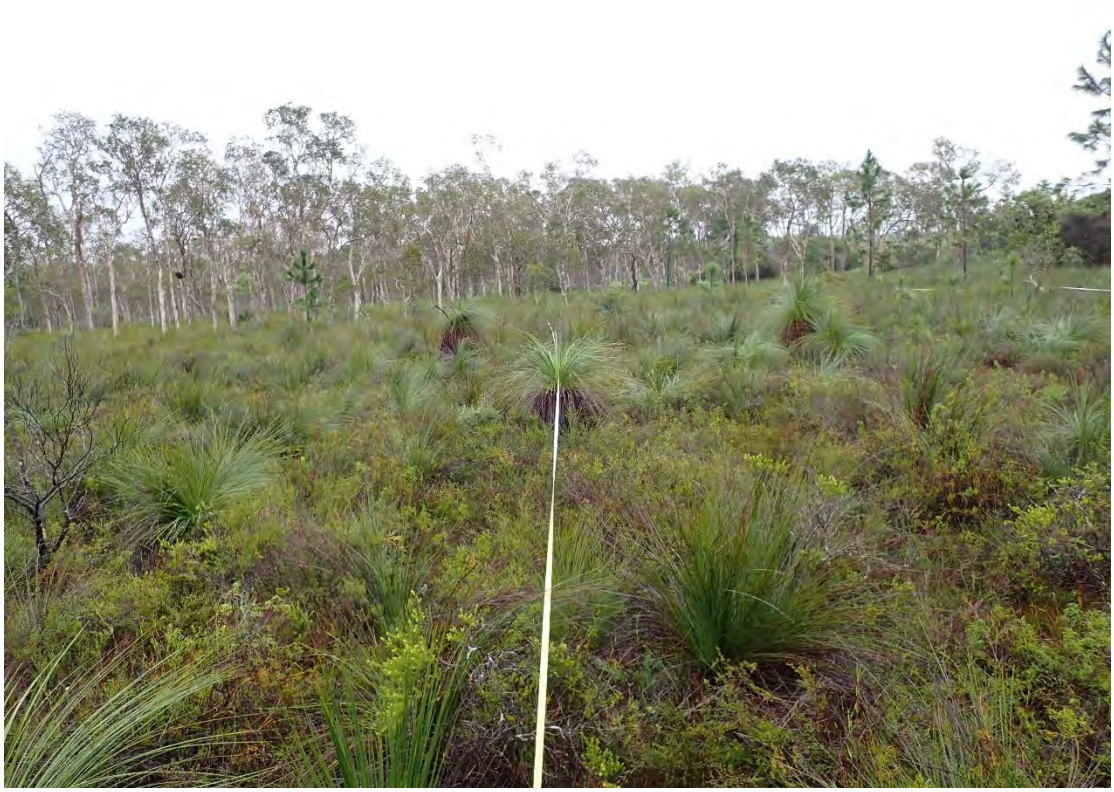
Additional Species: *Cassytha glabella, Epacris obtusifolia*

Structural / Floristic Summary

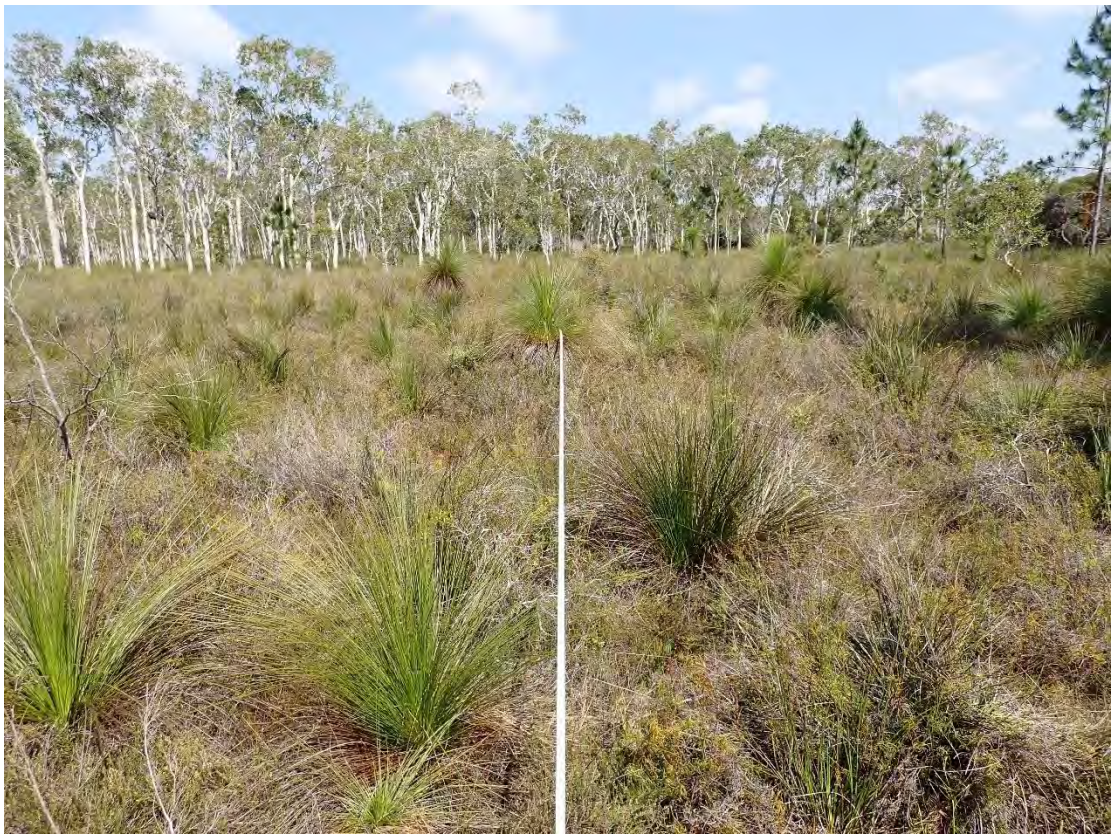
BioCondition Attribute		March 2024	October 2024
Native Plant Species Richness	Tree:		
	Shrub:	15	13
	Grass Tree	2	2
	Grass / Sedge	6	6
	Forbs and other:	5	5
Total Species No.**		**28/26**	
Native Shrubs	Projected Canopy Cover – Shrubs > 1m (%)	0	0
	Projected Canopy Cover – Shrubs >0.5 to <1m (%)	20.8	3.8
Native Ground cover (%):	Native perennial grass / sedge cover (%):	38.35	49.1
	Native shrubs (%)	19.95	12.1
	Grass tree	12.5	10.5

BioCondition Attribute		March 2024	October 2024
	Organic litter cover (%):	18.4	17.85
	Native forb cover (%)	2.65	1.75
Coarse woody debris:	Total length (m) of debris ≥ 10cm diameter and ≥0.5m in length per hectare	0	0
Non-native plant cover	Non-native Grasses	0	0
	Non-native shrubs	0.4	0.7

**** Excludes Exotic Species**



Plot 5b Centre to Start: March 2024 (above) and October 2024 (below).



Plot 5b – Centre to End: March 2024 (above) and October 2024 (below).

Plot 5b – Centre to South; March 2024 (above) and October 2024 (below).

Plot 5b – Centre to North: March 2024 (above) and October 2024 (below).

Survey Locality 5c

Date of Assessment: 24.03.24 / 24.10.24
Plot Size:50 m linear transect (Canopy Cover); 50 x 4m transect for S2 shrubs >0.5m; 10 x 1m x 1m quadrats for Ground Cover.
Location (Plot Centreline): *Start* -26.99467/ 153.15883; *Finish* -26.99447/ 153.15929
Structure: Heath

Shrub Cover – Canopy Intercept (>50cm)** (summarised 50 m transect)

March 2024

Intercept (m)	Species	Shrubs > 1m		Shrubs >0.5 to <1m	
		Intercept S1	Height (M)	Intercept S1	Height (M)
32.8 – 33.7	*Leptospermum semibaccatum*			0.9	0.8
37.0 – 38.0	*Baeckea frutescens*	0.4	1.2		
47.1 – 47.9	*Leptospermum semibaccatum*	1.0	4.0		
45.1 – 46.2	*Banskia aemula*	1.1	4.0		
48.5 - 50	*Agiortia pedicellata*	1.5	3.0		
Total Cover		**4.0**		**0.9**	
Median Height			**3.2**		**0.8**

*** Tree not included in cover calculation

October 2024

Intercept (m)	Species	Shrubs > 1m		Shrubs >0.5 to <1m	
		Intercept S1	Height (M)	Intercept S1	Height (M)
32.8 – 33.6	*Leptospermum semibaccatum*			0.8	0.7
37.3 – 37.7	*Baeckea frutescens*	0.4	1.2		
45.0 – 46.0	*Banskia aemula*	1.0	4.0		
48.5 - 50	*Agiortia pedicellata*	1.5	3.0		
Total Cover		**2.9**		**0.8**	
Median Height			**2.4**		**0.7**

*** Tree not included in cover calculation

Stem Counts (50 x 4) – Shrubs > 0.5m

Species	50 m x 4 m Stems (50x4m) March 2024	50 m x 4 m Stems (50x4m) October 2024
Persoonia virgata		
Leucopogon leptospermoides	2	3
Leptospermum semibaccatum	15	8
Dillwynia floribunda		

Strangea linearis	1	1
Agiortia pedicellata	2	3
Leptospermum polygalifolium	7	7
Homoranthus virgatus	5	1
Baeckea frutescens	4	3
Melaleuca pachyphylla	2	2
Melaleuca quinquenervia	1	1
Boronia falsifolia		1
Xanthorrhoea johnsonii		
Totals	**39**	**30**

Ground Cover %- 1 x 1m Sub-plots

March 2024

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean March 2024
Native perennial grass / sedges	*Caustis recurvata*	1		10	5	5	15	10	10	20	5	
	Hypolaena fastigiata					2.5					1	
	Gahnia sieberiana		30									
	Sporodanthus interruptus	10	20		15	10	5		5			
	Baloskion tenuiculme	5				30	25	10	25	5	10	
	Lomandra elongata			2.5	1							
	Eriachne pallescens var. gracilis	10	2.5	5				2.5	2		2.5	**31.75**
Native forbs and other spp.	*Pimelea liniifolia*	1	1					1				
	Cassytha glabella											
	Hibbertia salicifolia											
	Laxmannia compacta											
	Mitrasacme paludosa					1						
	Mirbellia rubiifolia											**1.7**

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean March 2024
	Cryptostylis erecta	1	1									
	Drosera bipinnata											
	Gonocarpus micranthus				1							
	Drosera bipinnata	1		1	1		1	1	1		1	
	Pseudanthus orientalis					1			1			
	Patersonia sericea							1				
Native shrubs ,<1m	*Leucopogon leptospermoides*			5		5			10			
	Strangea linearis			2.5	2.5	5			10	2		
	Leptospermum semibaccatum					10	10	15	10	10	10	
	Baeckea frutescens	20	2.5									
	Baeckea imbricata											
	Dyllwynia floribunda				1							
	Ochrosperma lineare			5		1	2		1		5	
	Homoranthus virgatus									2	5	
	Leptospermum polygalifolium							15	5			
	Sprengelia sprengelioides											
	Persoonia virgata											
	Acacia bauerii						5	5				**18.15**
Grass Tree	*Xanthorhoea fulva*	20	30	15	60	10	10	10	5	30	25	**21.5**
Cryptogams	Cryptogams					2		2.5	2.5		2	**0.9**
Bare Ground	Bare	10	5	15	2.5	2.5	5	0	10		10	**6.0**
Exotic Shrubs	*Pinus elliottii***									0.5		**0.1**
Leaf litter	Leaf	21	8	39	11	15	22	27	2.5	31	22.5	**19.9**
Timber (>/= 10cm)												
Total		**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100%**

Additional Species: *Xyris complanata, Hibbertia salicifolia, Melalueca pachyphylla, Blechnum cartiligineum*

October 2024

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean Oct 2024
Native perennial grass / sedges	*Caustis recurvata*			2.5	20		30	10	10	10	2.5	**37**
	Hypolaena fastigiata					1		2.5		1	1	
	Gahnia seiberiana		25									
	Sporodanthus interruptus	30	20	10	20		2.5	10				
	Baloskion tenuiculme	10		20	5	20	30	10	40	5	15	
	Lomandra elongata			1	1							
	Eriachne pallescens var. gracilis			2.5	2.5							
Native forbs and other spp.	*Pimelea liniifolia*			1							1	**1.1**
	Cassytha glabella											
	Cryptostylis erecta											
	Mitrasacme alsinoides					1						
	Laxmannia gracillis								1			
	Pseudanthus orientalis								1			
	Gonocarpus micranthus											
	Mirbellia rubiifolia											
	Hibbertia salicifolia	2.5										
Native shrubs ,<1m	*Leucopogon leptospermoides*			1			10	2.5			2.5	**10.4**
	Strangea linearis			2.5	2.5			2.5	5			
	Leptospermum semibaccatum					2.5	5	15		5	5	
	Baeckea frutescens	10	10		5							
	Boronia falcifolia											
	Ochrosperma lineare			2.5		1			1			
	Homoranthus virgatus						1	2.5	5		2.5	

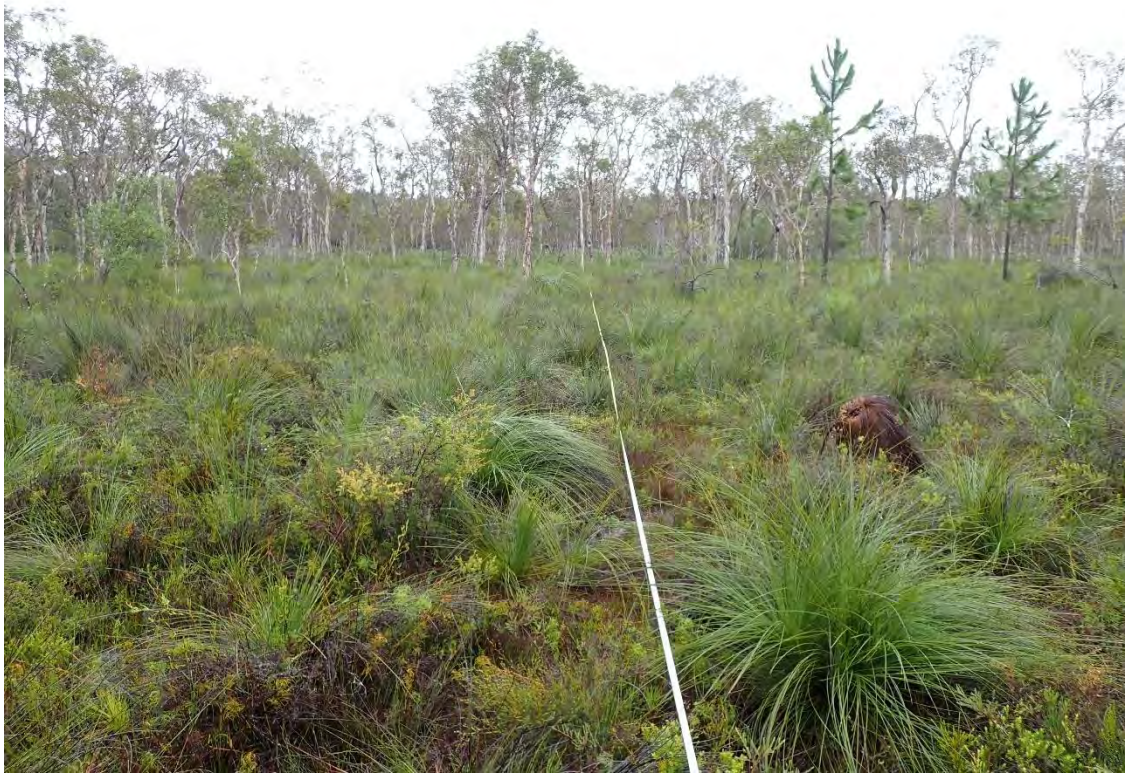
Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean Oct 2024
	Leptospermum polygaliifolium											
	Epacris pulchella											
	Dillwynia floribunda										2.5	
Grass Tree	*Xanthorhoea fulva*	10	30	30	20	15	5	15	5	40	20	**19.0**
Cryptogams											0	**0**
Bare Ground		10	5	20	2.5	5	10	5	15		10	**8.25**
Exotic Shrubs	*Pinus elliottii***											
Leaf litter		27.5	10	7	20.5	54.5	6.5	22.5	17	39	38	**24.25**
Timber (>/= 10cm)												
Total		**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100%**

Additional Species: *Blechnum cartiligineum, Banksia aemula, Melaleuca pachyphylla, Melaleuca quinquenervia, Boronia falcifolia*

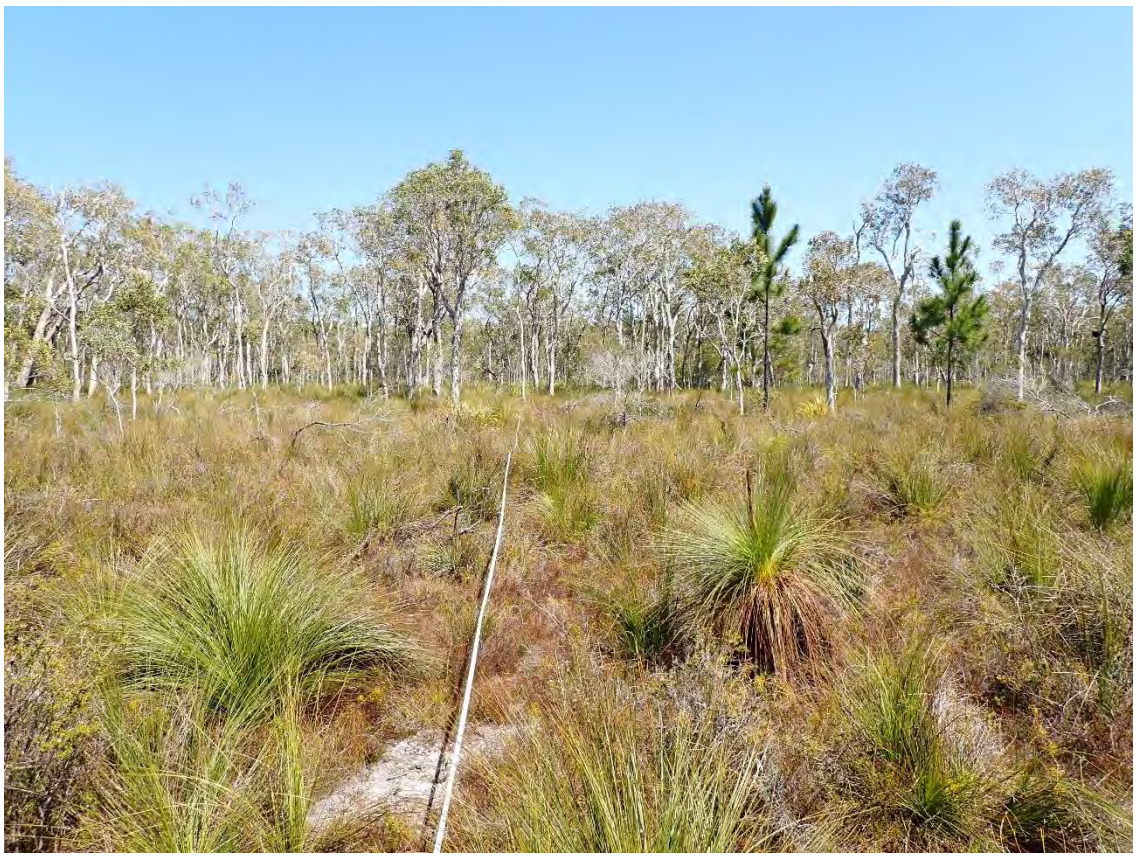
Structural / Floristic Summary

BioCondition Attribute		March 2024	October 2024
Native Plant Species Richness	Tree:	.	
	Shrub:	13	13
	Grass Tree	2	2
	Grass / Sedge	7	8
	Forbs and other:	10	7
Total Species No.**		**32/30**	
Native Shrubs	Projected Canopy Cover – Shrubs > 1m (%)	4	2.9
	Projected Canopy Cover – Shrubs >0.5 to <1m (%)	0.9	0.8
Native Ground cover (%):	Native perennial grass / sedge cover (%):	31.75	37.0
	Native shrubs (%)	18.15	10.4
	Grass tree	21.5	19
	Organic litter cover (%):	19.9	24.25
	Native forb cover (%)	1.7	1.1
Coarse woody debris:	Total length (m) of debris ≥ 10cm diameter and ≥0.5m in length per hectare	0	0
Non-native plant cover	Non-native Grasses%	0	0
	Non-native shrubs %	0.1	0

**** Excludes Exotic Species**



Plot 5c – Centre to Start: March 2024 (Above) and October 2024 (Below).



Plot 5c – Centre to End: March 2024 (Above) and October 2024 (Below).

Plot 5c – Centre to Right: March 2024 (Above) and October 2024 (Below).

Plot 5c – Centre to Left: March 2024 (Above) and October 2024 (Below).

Survey Locality 6a

Date of Assessment: 24.03.24 / 24.10.24

Plot Size:50 m linear transect (Canopy Cover); 50 x 4m transect for S2 shrubs >0.5m; 10 x 1m x 1m quadrats for Ground Cover.
Location (Plot Centreline): *Start* -26.985 / 153.1540431; Centre -26.9849 / 153.1542562
Finish -26.9847/ 153.1544874
Structure: Heath

Shrub Cover – Canopy Intercept (>50cm)** (summarised 50 m transect)

March 2024

Intercept (m)	Species	Shrubs > 1m		Shrubs >0.5 to <1m	
		Intercept S1	Height (M)	Intercept S1	Height (M)
3.0 – 5.5	*Banksia aemula*	2.5	3.5		
7.1 – 7.5	*Leptospermum semibaccatum*			0.4	0.5
10.4 – 11.5	*Baeckea frutescens*	1.1	1.6		
12.0 – 13.3	*Baeckea frutescens*	1.3	1.0		
15.3 – 16.6	*Baeckea frutescens*	1.3	1.0		
22.2- 23.4	*Banksia oblongifolia*			1.2	0.7
28.3 – 29.5	*Banksia oblongifolia*			1.2	0.6
30 – 30.5	*Phyllota phyllicioides*	0.5	1.0		
31.6 – 32.6	*Banksia oblongifolia*			1.0	0.7
33.9 – 34.3	*Phyllota phyllocioides*	0.4	1.0		
35.7 – 36.9	*Phyllota phyllocioides*	1.2	1.0		
37.1 – 37.5	*Phyllota phyllocioides*	0.4	1.0		
37.8 – 39.7	*Phyllota phyllocioides*	0.9	1.0		
40.4 – 40.9	*Phyllota phyllocioides*	0.5	1.0		
44.6 – 45.5	*Leptospermum liversidgei*			0.9	0.6
46.6 – 47.2	*Banksia oblongifolia*			0.6	0.5
48.3 – 48.9	*Leptospermum liversidgei*			0.6	0.5
49.5 – 49.7	*Leptospermum liversidgei*			0.2	0.5
49.5 – 50.0	*Phyllota phyllocioides*	0.5	1.0		
Total Cover		**10.6**		**6.1**	
Median Height			**1.8**		**0.7**

*** Tree not included in cover calculation

October 2024

Intercept (m)	Species	Shrubs > 1m		Shrubs >0.5 to <1m	
		Intercept S1	Height (M)	Intercept S1	Height (M)
1.7 – 1.9	*Leptospermum semibaccatum*			0.2	0.7
3.1 – 5.5	*Banksia aemula*	2.4	3.5		
10.0 – 11.2	*Baeckea frutescens*	1.2	2.0		
12.2 – 13.2	*Baeckea frutescens*	1.0	1.0		
14.9 – 15.2	*Leptospermum semibaccatum*			0.3	0.6
15.4 – 16.6	*Baeckea frutescens*	1.2	1.0		
22.8 – 23.5	*Banksia oblongifolia*			0.7	0.6
28.1 – 29.1	*Phyllota phylicoides*	1.0	1.5		
28.8 – 29.4	*Banksia oblongifolia*			0.6	0.6

Intercept (m)	Species	Shrubs > 1m		Shrubs >0.5 to <1m	
		Intercept S1	Height (M)	Intercept S1	Height (M)
31.7 – 32.5	*Banksia oblongifolia*			0.8	0.6
33.9 – 34.3	*Phyllota phyllocioides*	0.4	1.0		
35.7 – 36.1	*Phyllota phyllocioides*	0.4	1.0		
37.0 – 39.5	*Phyllota phyllocioides*	2.5	1.0		
40.2 – 41.1	*Banksia oblongifolia*			0.9	0.55
45.8 – 46.1	*Phyllota phyllocioides*	0.3	1.0		
46.5 – 47.2	*Banksia oblongifolia*			0.7	0.8
48.3 – 49.0	*Leptospermum liversidgei*			0.7	0.7
49.4 – 49.7	*Leptospermum liversidgei*			0.3	0.8
49.9 – 50.0	*Phyllota phyllocioides*			0.1	0.8
Total Cover		**10.4**		**5.3**	
Median Height			**1.8**		**0.7**

*** Tree not included in cover calculation

Stem Counts (50 x 4) – Shrubs > 0.5m

Species	50 m x 4 m Stems (50x4m) March 2024	50 m x 4 m Stems (50x4m) Oct 2024
	S2	
Persoonia virgata	1	
Banksia aemula	1	1
Banksia oblongifolia	23	13
Epacris pulchella		8
Leptospermum liversidgei	19	7
Leptospermum semibaccatum		1
Boronia falcifolia	28	9
Sprengelia sprengeliodes	1	
Leucopogon leptospermoides	15	12
Baeckea frutescens	6	22
Dilwynnia floribunda	8	
Epacris obtusifolia	1	
Strangea linearis		2
Phyllota phylicoides	194	211
Sprengelia sprengelioides		
Pultenaea paleacea	4	1
Leptospermum polygalifolium	2	4
Totals	**303**	**291**

Ground Cover %- 1 x 1m Sub-plots

March 2024

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean March 2024
Native perennial grass / sedges	*Caustis recurvata*	2		2	2.5							
	Sporodanthus interruptus	10	40	60	60	30	20	10	40	30	30	
	Lomandra longifolia											
	Lomandra elongata				1							
	Hypolaena fatigiata											
	Lomandra longifolia			2								33.95
Native forbs and other spp.	*Pimelea liniifolia*	1	1			1	2	1		2	2	
	Cassytha glabella			1	1	1	1			1		
	Patersonia sericea			1								
	Pseudanthus orientalis			1			1	2		1		
	Mirbellia rubiifolia							2.5				
	Burchardia umbellata			1								
	Drosera binata	1		1	1							
	Hibbertia salicifolia					2.5						3.5
Native shrubs ,<1m	*Boronia falcifolia*		2	10	1	5	5	1	2		1	
	Aotus lanigera					1		1		1	2	
	Baeckea imbricata			1	1	2	2			5		
	Banksia oblongifolia						15		10			
	Leptospermum semibaccatum	25	10	10	10		1					
	Strangea linearis				2.5							
	Leptospermum liversidgei					2						
	Sprengelia sprengelioides		2			2			2			
	Dillwynnia floribunda	10	5	1								
	Ochrosperma lineare				1							
	Pultenaea paleaceae						1					
	Baeckea frutescens						5				10	
	Phyllota phylicoides							2.5				16.5
Grass Tree	*Xanthorrhoea fulva*				10	40	40	60	30	10	30	22

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean March 2024
Cryptogam												
Bare Ground	Bare			5	5		5			5		2
Exotic Shrubs												0
Leaf litter	Leaf	51	40	4	4	13.5	2	20	16	45	25	22.05
Timber (>/= 10cm)												
Total		**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100%**

October 2024

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean Oct 2024
Native perennial grass / sedges	*Caustis recurvata*		2.5		2.5							37.75
	Sporodanthus interruptus	70	30	10	5	30	30	5	40	40	10	
	Baloskion tenuiculme			50	50							
	Hypolaena fastigiata		2.5									
	Lomandra elongata											
Native forbs and other spp.	*Pimelea liniifolia*											1
	Cassytha glabella									1		
	Hibbertia salicifolia								1			
	Pseudanthus orientalis		1									
	Burchardia umbellata			2						2		
	Selaginella uliginosa									1		
	Patersonia sericea											
	Gonocarpus micranthus									1		
	Burchardtia umbellata									1		
Native shrubs ,<1m	*Boronia falcifolia*	1	2.5	5		2.5	2.5	1	1	2.5	2.5	11.5
	Baeckea imbricata			2.5	2.5	5	5			5	5	
	Banksia oblongifolia								10			
	Leptospermum liversidgei											
	Dylwynnia floribuna	1	1			1	1					

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean Oct 2024
	Homoranthus virgatus											
	Leptospermum semibaccatum	2.5	2.5	5	2.5							
	Strangea linearis				2.5							
	Sprengelia sprengelioides		2.5			1				1	1	
	Olax retusa											
	Aotus lanigera								1		1	
	Epacris obtusifolia						2.5	2.5		1		
	Pultenaea paleaceae					2	2.5	1				
	Baeckea frutescens							1	2.5	15		
	Persoonia virgata						1					
	Ochrosperma lineare	1			1							
	Boronia falcifolia	1	2.5	5		2.5	2.5	1	1	2.5	2.5	
Grass Tree	*Xanthorrhoea fulva*				10	20	15	70	30	15	50	21
Cryptogam												
Bare Ground	Bare	0	0	0	5	5	0	0	0	0	0	1
Exotic Shrubs												
Leaf litter	Leaf	24.5	55.5	25	19	33.5	40.5	19.5	14.5	15	30.5	27.75
Timber (>/= 10cm)												
Total		**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100%**

Additional Species: *Stackhousia nuda*

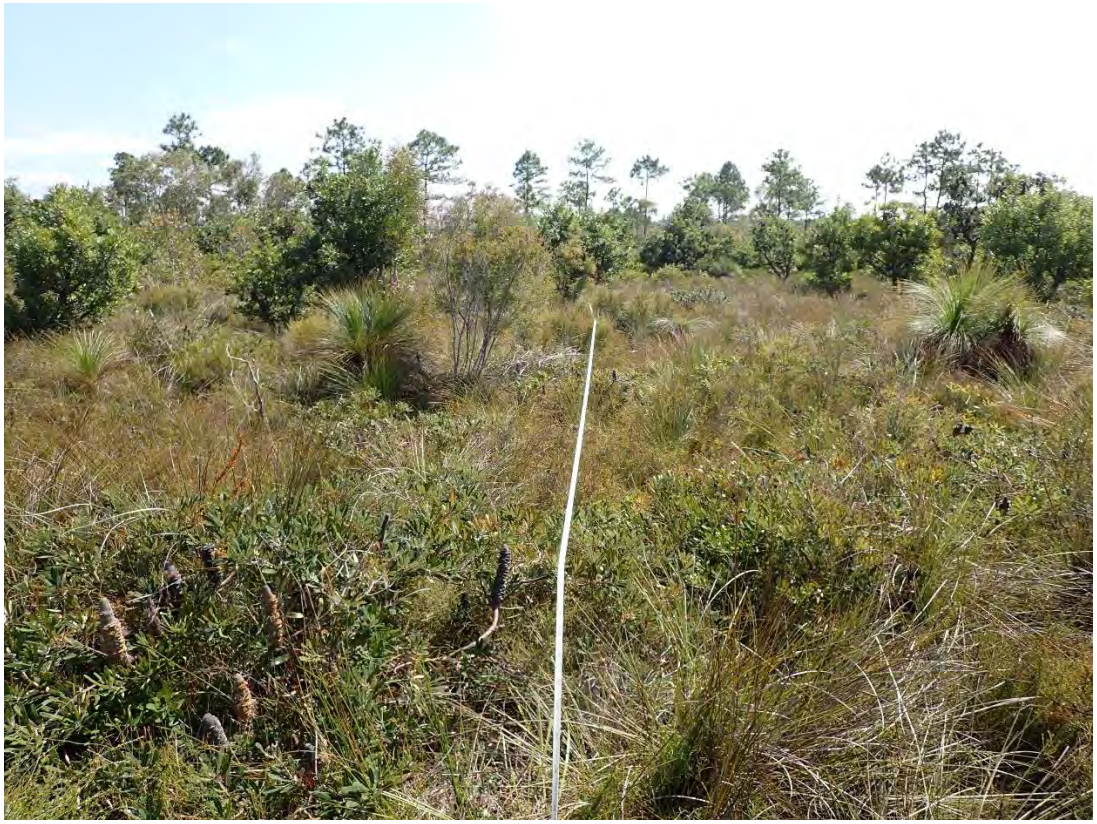
Structural / Floristic Summary

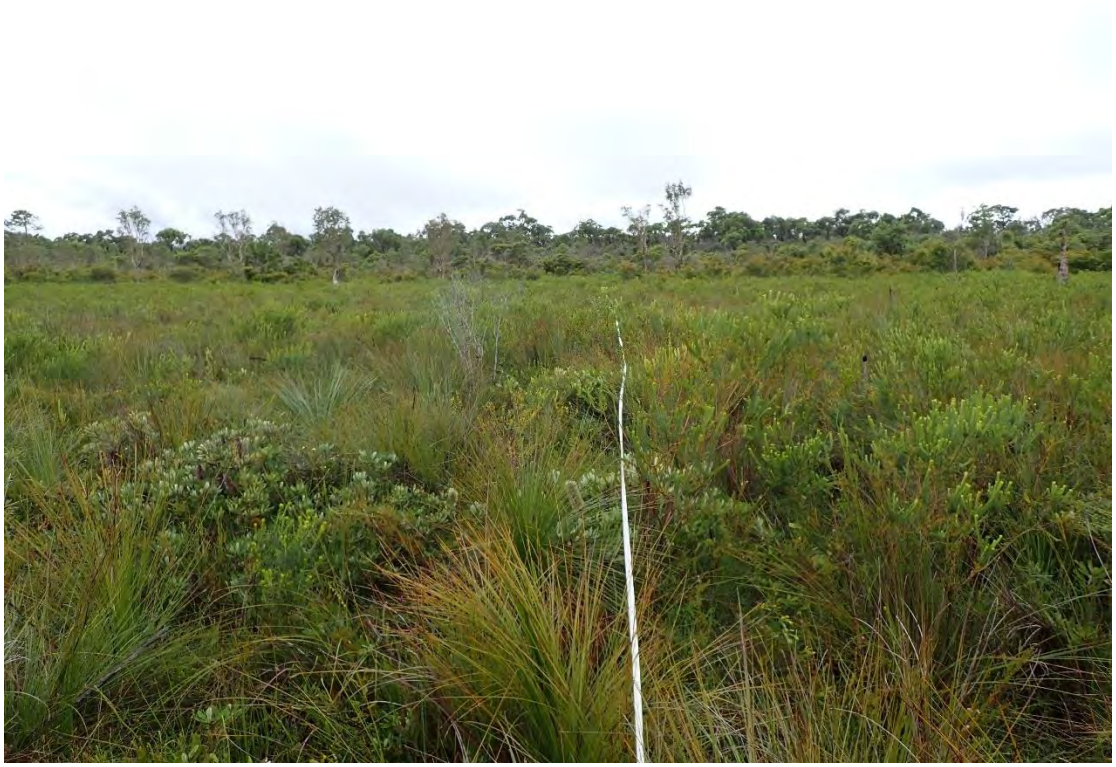
BioCondition Attribute		March 2024	October 2024
Native Plant Species Richness	Tree:		
	Shrub:	20	18
	Grass Tree	1	1
	Grass / Sedge	5	6
	Forbs and other:	8	12
Total Species**		**34/37**	
Native Shrubs	Projected Canopy Cover – Shrubs > 1m (%)	10.6	10.4
	Projected Canopy Cover – Shrubs >0.5 to <1m (%)	6.1	5.3
Native Ground cover (%):	Native perennial grass / sedge cover (%):	33.95	37.75
	Native shrubs (%)	16.5	11.5
	Grass tree	22	21

BioCondition Attribute		March 2024	October 2024
	Organic litter cover (%):	22.05	27.75
	Native forb cover (%)	3.5	1
Coarse woody debris:	Total length (m) of debris ≥ 10cm diameter and ≥0.5m in length per hectare		
Non-native plant cover	Non-native Grasses%	0	0
	Non-native shrubs %	0	0

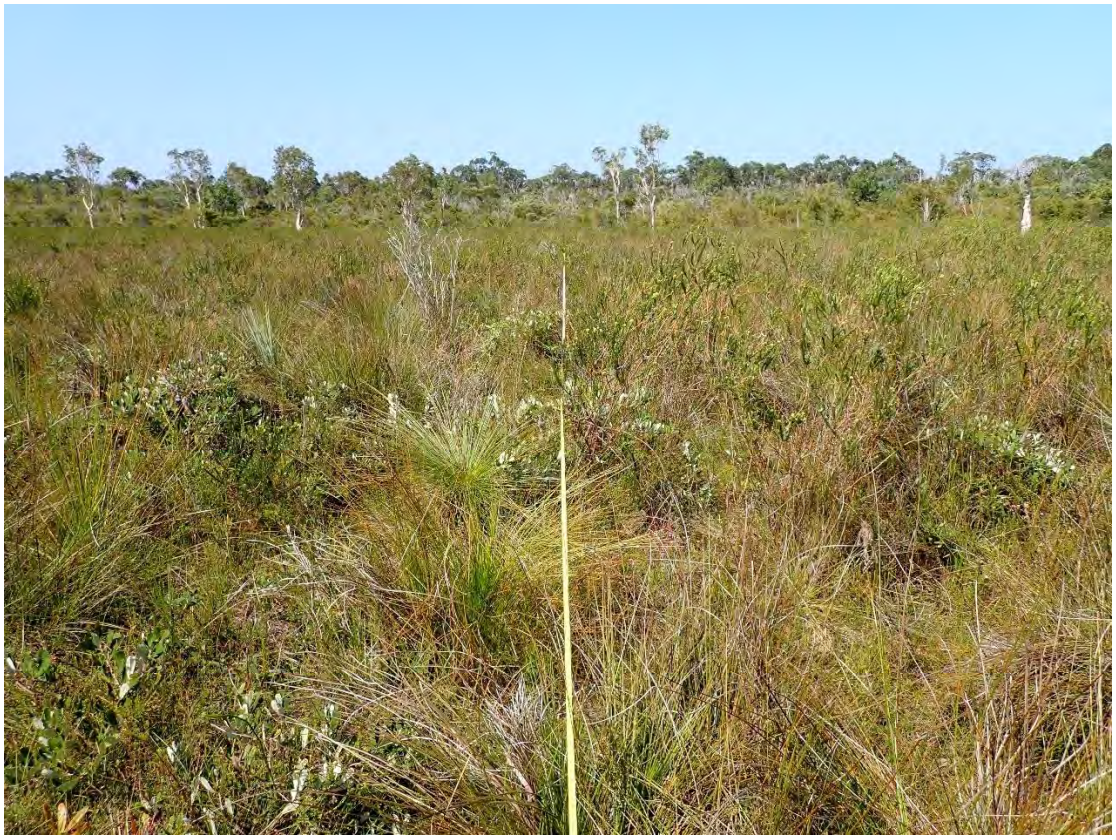
****Excludes Exotic Species**

Plot 6a – Centre to Start; March 2024 and October 2024 (Below).

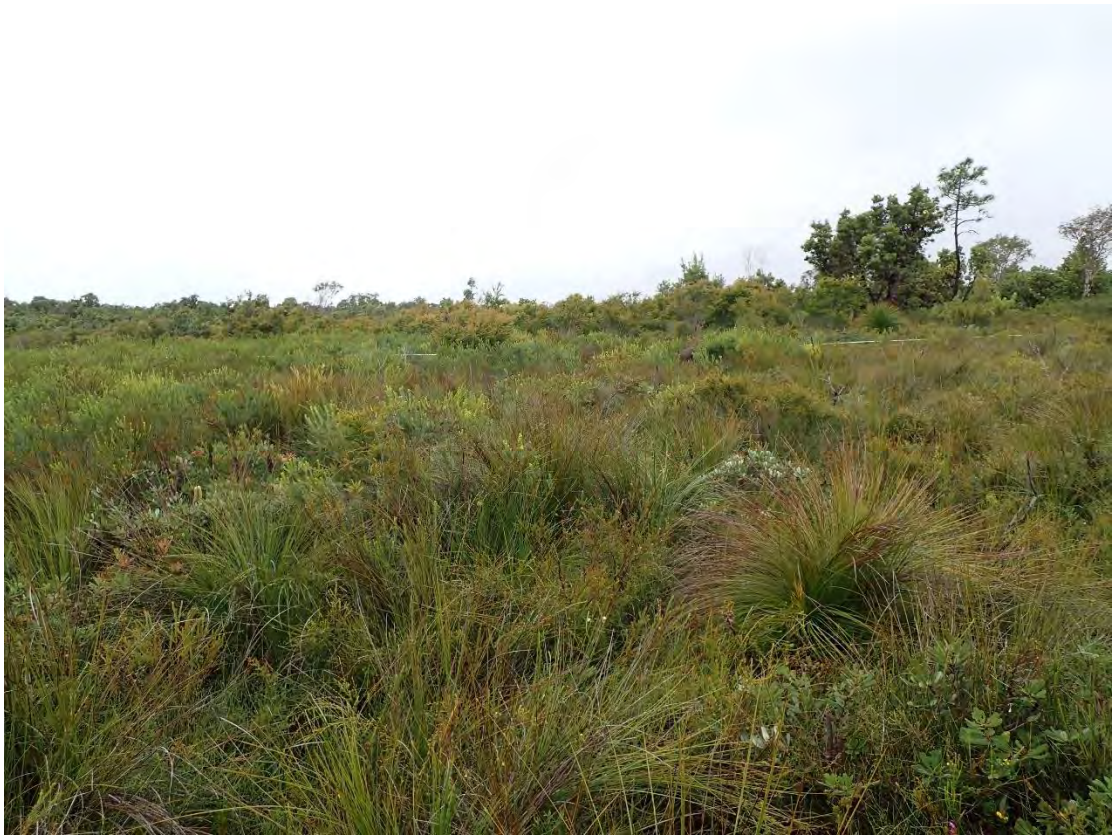




Plot 6a – Centre to End: March 2024 and October 2024 (Below).



Plot 6a – Centre North: March 2024 (Above) and October 2024 (Below)



Plot 6a – Centre to South: March 2024 (Above) and October 2024 (Below).

Survey Locality 6b

Date of Assessment: 24.03.24 / 24.10.24
Plot Size:50 m linear transect (Canopy Cover); 50 x 4m transect for S2 shrubs >0.5m; 10 x 1m x 1m quadrats for Ground Cover.
Location (Plot Centreline): *Start* -26.9852/ 153.1541529; Centre -26.985 / 153.1543768 *Finish* -26.9849 / 153.1545859
Structure: Heath

Shrub Cover – Canopy Intercept (>50cm)** (summarised 50 m transect)

March 2024

Intercept (m)	Species	Shrubs > 1m		Shrubs >0.5 to <1m	
		Intercept S1	Height (M)	Intercept S1	Height (M)
0.7 – 1.3	*Baeckea frutescens*			0.7	0.6
2.2 – 2.4	*Banksia oblongifolia*			0.2	0.6
3.7 – 4.0	*Banksia aemula*			0.3	0.5
12.8 – 13.9	*Banksia oblongifolia*			1.1	0.6
14.8 – 15.7	*Leptospermum semibaccatum*			0.9	0.6
16.3 – 18.4	*Banksia oblongifolia*			2.1	0.6
18.8 – 19.5	*Leptospermum liversidgei*	0.7	1.0		
21.3 – 22.2	*Baeckea frutescens*			0.9	0.6
25.4 – 25.8	*Phyllota phylicioides*	0.4	1.0		
26.2 – 26.5	*Baeckea frutescens*			0.3	0.6
27.6 – 28.3	*Phyllota phylicioides*	0.6	1.2		
29.4 – 31.1	*Phyllota phylicoides*	1.7	1.2	0.9	0.8
31.3 – 32.9	*Phyllota phylicoides*	1.6	1.3		
33.4 – 35.4	*Phyllota phylicoides*	0.6	1.0		
35.8 – 36.8	*Phyllota phylicoides*	1.0	1.0		
37.5 – 38.1	*Banksia oblongifolia*			0.6	0.8
39.5 – 40.4	*Phyllota phylicoides*	0.9	1.0		
40.9 – 42.2	*Phyllota phylicoides*	1.3	1.2		
42.7 – 43.9	*Phyllota phylicoides*	1.4	1.0		
46.8 – 50.0	*Phyllota phylicoides*	1.2	1.0		
Total Cover		**11.4**		**7**	
Median Height			**1.0**		**0.7**

*** Tree not included in cover calculation

October 2024

Intercept (m)	Species	Shrubs > 1m		Shrubs >0.5 to <1m	
		Intercept S1	Height (M)	Intercept S1	Height (M)
3.7 – 5.6	*Banksia aemula*	1.9	4		0.5
13.2 – 13.8	*Leucopogon leptospermoides*			0.6	0.6
13.4 – 13.8	*Banksia oblongifolia*			0.4	0.6
14.7 – 15.1	*Leptospermum semibaccatum*			0.4	0.6
16.8 – 18.4	*Banksia oblongifolia*			0.6	0.7
18.7 – 19.2	*Leptospermum polygalifolium*	0.5	1.0		
19.1 – 19.5	*Leucopogon leptospermoides*			0.4	0.6

Intercept (m)	Species	Shrubs > 1m		Shrubs >0.5 to <1m	
		Intercept S1	Height (M)	Intercept S1	Height (M)
25.5 – 26.0	*Phyllota phylicioides*	0.5	1.0		
27.6 – 28.3	*Phyllota phylicioides*	0.7	1.0		
28.8 – 31.2	*Phyllota phylicioides*	0.4	1.0		
28.8 – 30.1	*Leptospermum liversidgei*	0.3	1.2		
32.0 – 32.7	*Phyllota phylicioides*	0.7	0.7		
33.5 – 34.8	*Phyllota phylicioides*	1.3	1.1		
35.0 – 35.3	*Leptospermum liversidgei*	0.3	1.0		
35.4 – 36.3	*Phyllota phylicioides*	0.9	1.0		
37.2 – 37.6	*Phyllota phylicioides*	0.4	1.1		
39.4 – 39.9	*Phyllota phylicioides*	0.5	1.1	0.5	0.9
40.7 – 41.0	*Phyllota phylicioides*	0.3	0.9		
41.5 – 43.6	*Phyllota phylicoides*	1.1	1.3		
44.2 – 44.5	*Phyllota phylicoides*			0.3	0.9
45.5 – 47.7	*Phyllota phylicoides*	0.9	1.0		
49.6 – 49.8	*Phyllota phylicoides*	0.2	0.9	0.2	0.8
Total Cover		**10.9**		**3.4**	
Median Height			**1.2**		**0.9**

*** Tree not included in cover calculation

Stem Counts (50 x 4) – Shrubs > 0.5m

Species	50 m x 4 m Stems (50x4m) March 2024	50 m x 4 m Stems (50x4m) October 2024
	S2	
Persoonia virgata		
Banksia aemula	1	1
Banksia oblongifolia	13	13
Leptospermum liversidgei	9	7
Boronia falcifolia	3	9
Leucopogon leptospermoides	7	12
Baeckea frutescens	21	22
Dillwynnia floribunda	3	
Olax retusa		
Epacris obtusifolia		8
Phyllota phylicoides	237	211
Pultenaea paleacea	2	1
Strangea linearis	2	
Leptospermum polygalifolium	4	4

Aotus lanigera	2	0
Leptospermum semibaccatum	8	1
Totals	**312**	**289**

Ground Cover %- 1 x 1m Sub-plots

March 2024

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean March 2024
Native perennial grass / sedges	*Caustis recurvata*				2	5	5					
	Sporodanthus interruptus	30	50	30	50	25	30	30	30	10	20	
	Baloskion tenuiculme											
	Schoenus calostachys											
	Lomandra elongata											
	Lomandra longifolia	10	10	1	1	1						**34**
Native forbs and other spp.	*Drosera binata*				1	1	1					
	Pimelea linifolia								1			
	Burchardia umbellata							1	1			
	Cassytha glabella			1	1		1	1				
	Selaginella uliginosa										1	
	Pattersonia sericea									1	1	
	Hibbertia salicifolia							2	25	1	1	
	Pseudanthus orientalis											
	Gonocarpus micranthus											**4.2**
Native shrubs ,<1m	*Boronia falcifolia*	1				25	10					
	Persoonia virgata			1								
	Baeckea imbricata											
	Leucopogon leptospermoides				2	2						
	Strangea linearis			1				2				
	Leptospermum liversidgei											**14.1**

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean March 2024
	Leptospermum polygalifolium					1						
	Banksia oblongifolia	20	5				5					
	Leptospermum semibaccatum	2	1	20	2		2	1				
	Baeckea frutescens					2	10				1	
	Dyllwynia floribunda	5	2	1								
	Aotus lanigera								1			
	Sprengelia sprengeliodes	2						2				
	Pultenaea paleaceae											
	Phyllota phylicioides						2		5	5		
Grass Tree	*Xanthorrhoea fulva*	25	10		20	1		20	20	60	30	**23.5**
Cryptogams												**0**
Bare Ground	Bare	0	0	0	0	5	10	0	5	0	5	**2.5**
Exotic Shrubs	*Exotic*											**0**
Leaf litter	Leaf	39	37.5	24	29	17	21.5	24	40	21.5	39	**21.7**
Timber (>/= 10cm)												
Total		**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100%**

Additional species: *Ochrosperma lineare*

October 2024

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean October 2024
Native perennial grass / sedges	*Caustis recurvata*					2.5	10					**40.05**
	Sporodanthus interruptus	40	50	40	40	60	40	30	25	10	10	
	Lomandra longifolia											
	Baloskion tenuiculme				10		5					
	Schoenus scabripes				1							
	Lomandra elongata			5		1	1					
	Lomandra sp.	10	10									

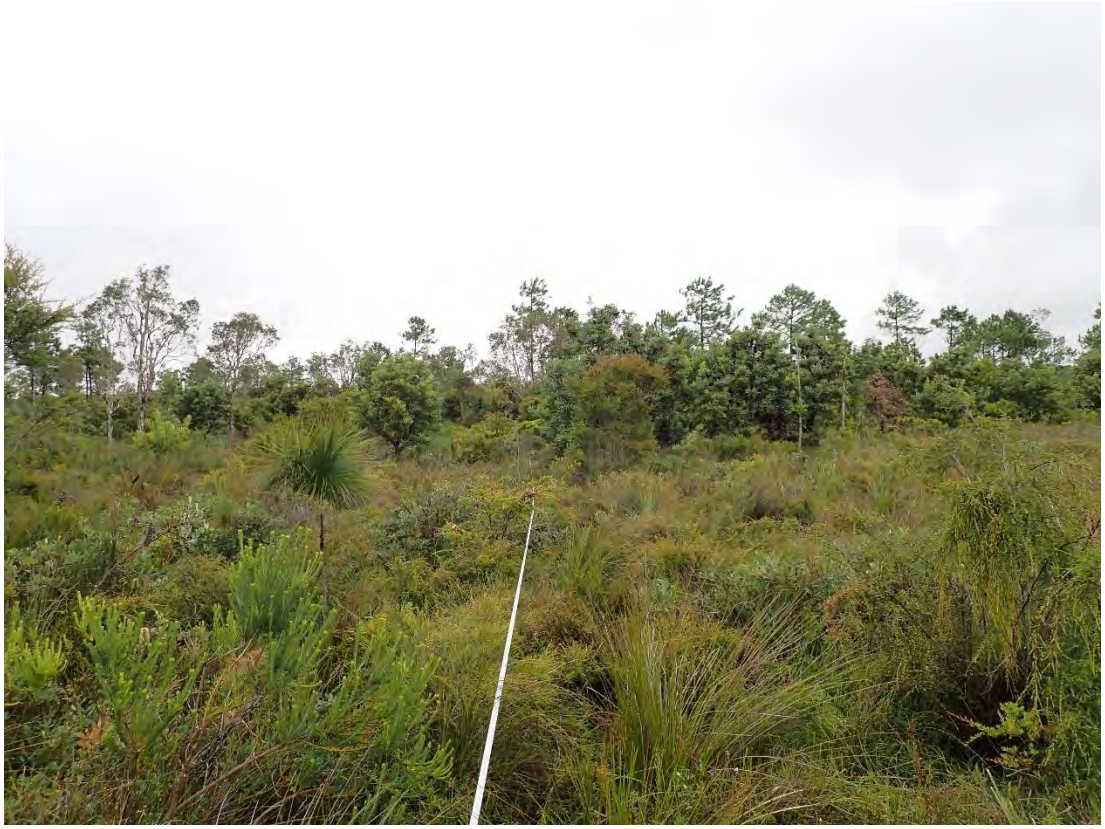
Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean October 2024
Native forbs and other spp.	*Pimelia liniifolia*	1	1									**1.7**
	Selaginella uliginosa										1	
	Hibbertia salicifolia								5		1	
	Cassytha glabella				1							
	Burchardia umbellata					1		5			1	
	Patersonia sericea											
	Gonocarpus micranthus											
Native shrubs ,<1m	*Boronia falcifolia*					2.5	2.5					**10.85**
	Baeckea imbricata				2.5	10					2.5	
	Leucopogon leptospermoides			1		1						
	Homoranthus virgatus											
	Banksia oblongifolia	10										
	Leptospermum semibaccatum			10	5		10					
	Baeckea frutescens				10			5	10	1	10	
	Aotus lanigeria									1		
	Sprengelia sprengelioides								2.5			
	Ochrasperma linearis			1								
	Homoranthus virgatus											
	Dyllwynia floribunda	2.5	1	2.5	2.5		2.5					
	Leptospermum polygaliifolium											
	Phyllota phylicoides											
Grass Tree	*Xanthorrhoea fulva*	10	5	5	10			25	30	60	50	**19.5**
Cryptogams												
Bare Ground	Bare	0	0	1	0	5	0	0	0	0	0	**0.6**
Exotic Shrubs												
Leaf litter	Leaf	26.5	33	35.5	18	22	29	35	27.5	28	24.5	**27.90**
Timber (>/= 10cm)												
Total		**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100%**

Additional Species: *Olax retusa, Goodenia stelligera*

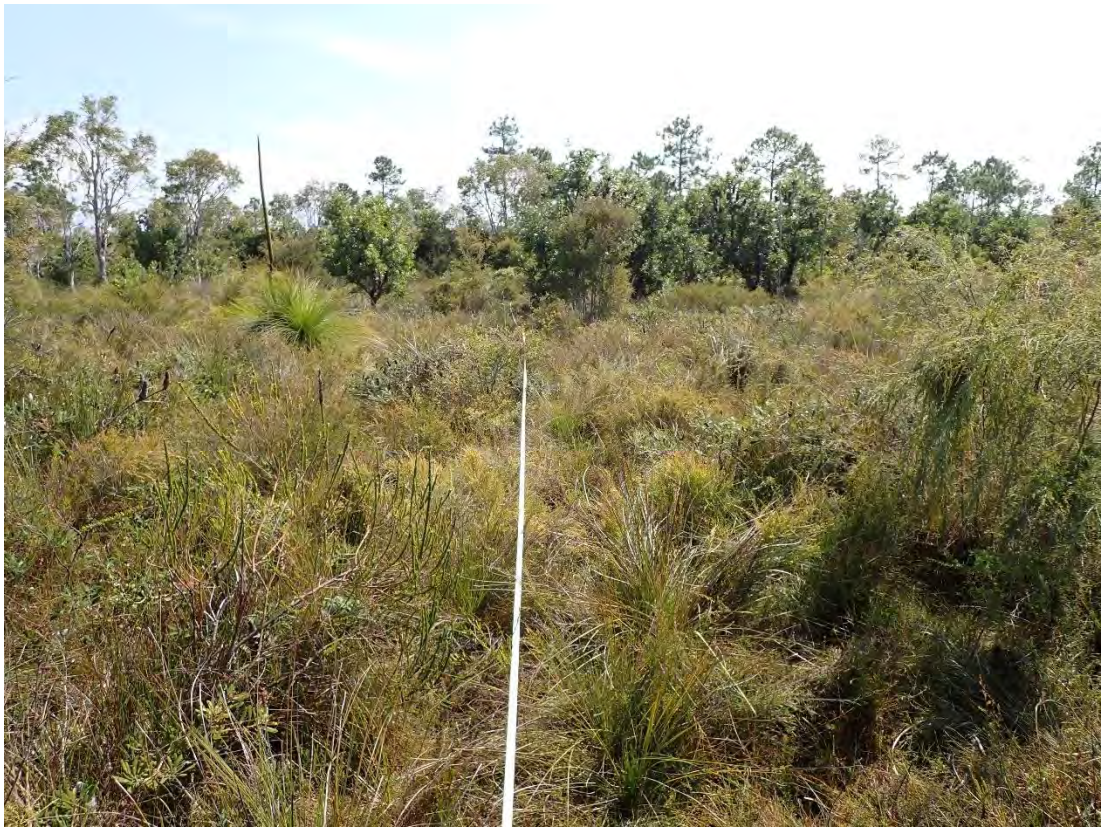
Structural / Floristic Summary.

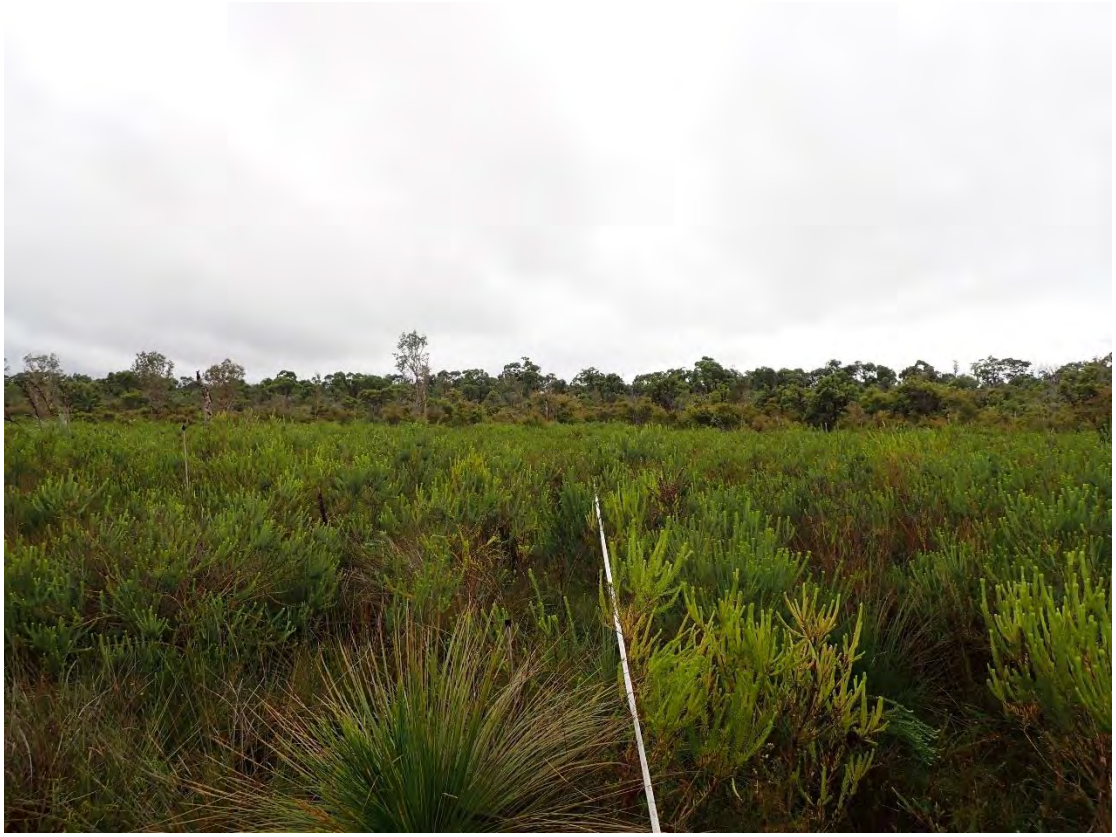
BioCondition Attribute		March 2024	November 2024
Native Plant Species Richness	Tree:		
	Shrub:	17	18
	Grass Tree	1	1
	Grass / Sedge	6	6
	Forbs and other:	6	9
Total Species No.**		**30/34**	
Native Shrubs	Projected Canopy Cover – Shrubs > 1m (%)	11.4	10.9
	Projected Canopy Cover – Shrubs >0.5 to <1m (%)	7	3.4
Native Ground cover (%):	Native perennial grass / sedge cover (%):	34.0	40.5
	Native shrubs (%)	14.1	10.85
	Grass tree	23.5	19.5
	Organic litter cover (%):	21.7	27.9
	Native forb cover (%)	4.2	1.7
Coarse woody debris:	Total length (m) of debris ≥ 10cm diameter and ≥0.5m in length per hectare	0	0
Non-native plant cover	Non-native Grasses%	0	0
	Non-native shrubs %	0	0

**** Excludes Exotic Species**



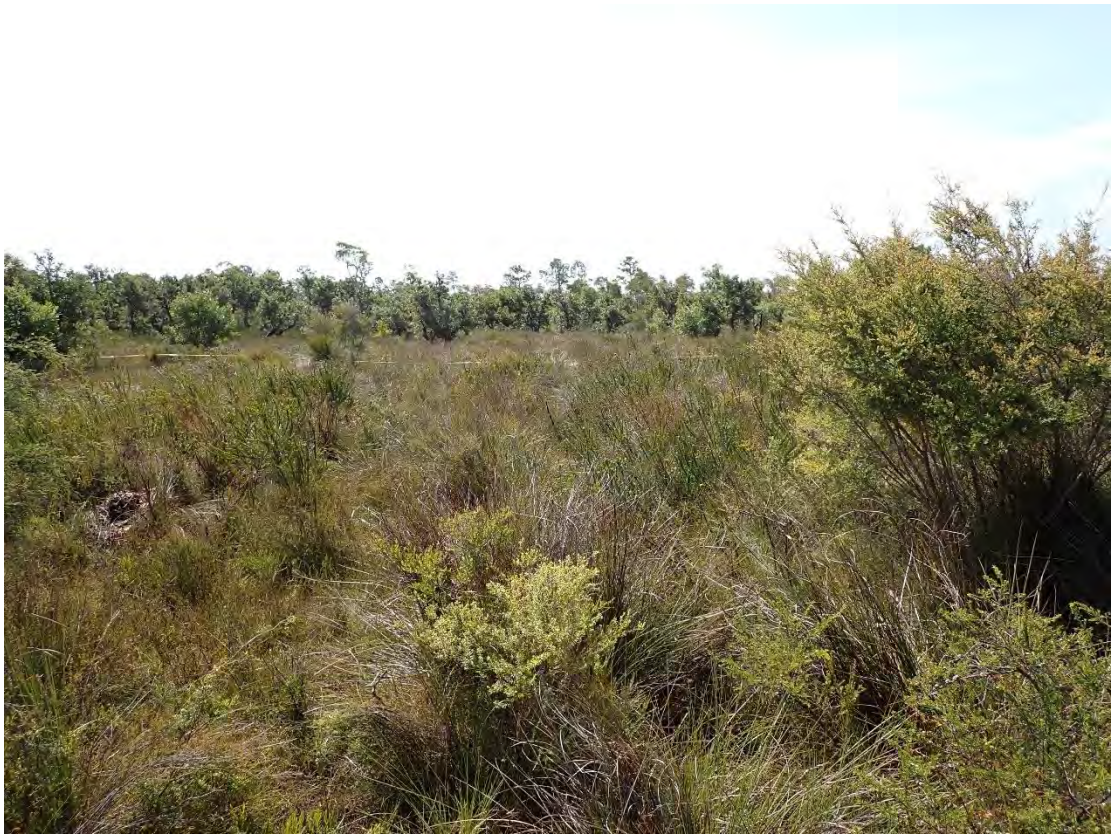
Plot 6b Centre to Start: March 2024 and October 2024 (Below)





Plot 6b – Centre to End: March 2024 and October 2024 (Below)

Plot 6b – Centre to North: March 2024 and October 2024 (Below)



Plot 6b – Centre to South: March 2024 and October 2024 (Below).

Survey Locality 6c

Date of Assessment: 24.03.24 / 24.10.24
Plot Size:50 m linear transect (Canopy Cover); 50 x 4m transect for S2 shrubs >0.5m; 10 x 1m x 1m quadrats for Ground Cover.
Location (Plot Centreline): *Start* -26.9852/ 153.1541529; *Finish* -26.9849 / 153.1545859
Structure: Heath

Shrub Cover – Canopy Intercept (>50cm)** (summarised 50 m transect)

March 2024

	Species	Shrubs > 1m		Shrubs >0.5 to <1m	
		Intercept S1	Height (M)	Intercept S1	Height (M)
1.0 – 2.8	*Phyllota phylicoides*	1.8	1.0		
4.6 – 5.1	*Phyllota phylicoides*	0.5	1.0		
6.4 – 8.9	*Phyllota phylicoides*	2.5	1.0		
8.9 -10.8	*Phyllota phylicoides*			0.5	0.8
12.5 – 13.0	*Baeckea frutescens*			0.7	0.7
13.4 – 13.6	*Phyllota phylicoides*	0.3	1.0		
13.9 – 14.9	*Baeckea frutescens*			1.4	0.7
16.2 – 21.6	*Phyllota phylicioides*	5.4	1.2		
22.1 – 22.8	*Melaleuca quinquenervia*	0.7	4.0		
24.1 – 24.6	*Phyllota phylicoides*	0.5	1.0		
25.0 – 25.7	*Banksia oblongifolia*			0.7	0.8
25.9 – 27.6	*Phyllota phylicioides*	1.7	1.0		
25.9 – 27.6	*Phyllota phylicoides*	1.7	1.0		
30.0 – 31.5	*Leptospermum polygaliifolium*	0.5	1.0		
44.4 – 45.4	*Phyllota phylicioides*	1.0	1.0		
45.9 – 46.6	*Phyllota phylicioides*	0.7	1.2		
48.0 – 48.2	*Boronia falsifolia*			0.2	0.6
48.5 -50	*Banksia aemula*	1.5	3		
Total Cover		**18.8**		**3.5**	
Median Height			**1.5**		**0.7**

October 2024

	Species	Shrubs > 1m		Shrubs >0.5 to <1m	
		Intercept S1	Height (M)	Intercept S1	Height (M)
0.7 – 2.8	*Phyllota phylicoides*	2.1	1.0		
4.7 – 5.1	*Phyllota phylicoides*	0.4	1.0		
6.1 – 8.8	*Phyllota phylicoides*	2.7	1.0		
10.1 – 10.8	*Phyllota phylicoides*	0.7	1.0		
12.5 – 13.2	*Baeckea fruitescens*	0.7	1.0		
13.5 – 14.1	*Baeckea frutescens*			0.6	0.7
14.4 – 15.3	*Phyllota phylicioides*	0.9	1.0		
14.4 – 15.1	*Baeckea fruitescens*			0.7	0.6
16.0 – 20.7	*Phyllota phylicoides*	4.7	1.1		

	Species	Shrubs > 1m		Shrubs >0.5 to <1m	
		Intercept S1	Height (M)	Intercept S1	Height (M)
21.1 – 21.5	*Phyllota phylicoides*	0.4	1.2		
22.2 – 24.0	*Melaleuca quinquenervia*	1.8	4.0		
24.4 – 25.6	*Banksia oblongifolia*			1.2	0.7
25.8 – 26.6	*Phyllota phylicoides*	1.8	1.2		
26.8 – 27.7	*Phyllota phylicoides*	0.9	1.2		
30.2 – 31.5	*Leptospermum polygsliifolium*	1.3	1.9		
44.5 – 45.4	*Phyllota phylicoides*	0.9	1.0		
48.5 – 50.0	*Banskia aemula*	1.5	3.0		
Total Cover		**20.8**		**2.5**	
Median Height			**2.5**		**0.7**

Stem Counts (50 x 4) – Shrubs > 0.5m

Species	50 m x 4 m Stems (50x4m) March 2024	0 m x 4 m Stems (50x4m) October 2024
	S1 – S2	
Persoonia virgata		
Banksia oblongifolia	11	12
Leucopogon leptospermoides	4	15
Boronia falcifolia	16	5
Phyllota phylicoides	170	135
Baeckea frutescens	15	17
Leptospermum liversidgei	12	15
Leptospermum polygalifolium	11	8
Diiwynnia floriubunda		
Melaleuca quinquenervia	2	1
Banksia aemula	2	2
Dilwynnia floribunda	3	
Epacris pulchella		1
Leptospermum semibaccatum	2	1
Totals	**248**	**212**

Ground Cover %- 1 x 1m Sub-plots

March 2024

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean March 2024
Native perennial grass / sedges	*Caustis recurvata*	15		5		5		5	5	5	10	
	Sporodanthus interruptus	40	50	20	40	30	40	30	10	40	40	
	Lomandra longifolia	2										
	Baloskion tenuiculme		5		5			5	2.5			40.95
Native forbs and other spp.	*Pimelea liniifolia*											
	Cassytha glabella	1	1		1	1			1			
	Sellaginella uliginosa			2	5					1		
	Burchardia umbellata											
	Patersonia sericea			1				1	1		1	
	Drosera binata				1		1	1		1		
	Pseudanthus orientalis											
	Gonocarpus micranthus											2.1
Native shrubs ,<1m	*Boronia falcifolia*		2					10	1		1	
	Baeckea imbricata		1	5				1	1	1	1	
	Baeckea frutescens			50	5						2	
	Dyllwinia floribunda	2				5	2			1	2	
	Leucopogon leptospermoides			5			2					
	Persoonia virgata											
	Banksia oblongifolia			5				10	70	5	5	
	Strangea linearis	5				1	2					
	Leptospermum semibaccatum	15	5		5	5	2					
	Pyllota phylicoides				1	1	2	1		1	2	
	Ochrosperma lineare									1	2	
	Agiortia pedicellata											
	Leptospermum polygaliifolium	2						5				
	Sprengelia sprengelioides		2					1				25.6

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean March 2024
Grass Tree	*Xanthorrhoea fulva*		10			30	20	20		10		9
Bare Ground	Bare	5	10	10	20	2.5	5	2.5	0	0	0	2
Leaf litter	Leaf	18	24	7	17	22	29	10	8.5	34	34	20.35
Timber (>/= 10cm)												
Total		**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100%**

October 2024

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean March 2024
Native perennial grass / sedges	*Caustis recurvata*	10	5					10		5	15	
	Sporodanthus interruptus	50	60	30	60	30	40	40	10	40		
	Lomandra elongata			1	1							
	Lomandra longifolia	2.5					5			2.5		
	Baloskion tenuiculme		1		5			5	1			**42.9**
Native forbs and other spp.	*Pimelea liniifolia*						1					
	Cassytha glabella					1						
	Sellaginella uliginosa		1	1	5		1	1				
	Goodenia stelligera			2.5								
	Stackhousia nuda										1	
	Patersonia sericea			1								
	Cryptostylis erecta					1						
	Burchardtia umbellata			1				2,5		1		**1.65**
Native shrubs ,<1m	*Boronia falcifolia*	1					1	2.5			1	
	Baeckea imbricata							1	1		2.5	
	Baeckea fruitescens			10								
	Ochrosperma lineare											
	Dylwinnia floribunda											**13.6**

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean March 2024
	Leucopogon leptospermoides		1	2.5	2.5			2.5		1		
	Banksia oblongifolia								50	10		
	Banksia aemula				2.5		1					
	Strangea linearis	2.5				5						
	Homoranthus virgatus										10	
	Sprengelia sprengelioides		1							1		
	Leptospermum semibaccatum	2.5	5				2.5	2.5				
	Leptospermum polygalifolium	1			2.5	2.5			1			
	Dilwynnia floribunda		1						1	1	1	
	Persoonia virgata										`	
	Phyllota phylicoides											
Grass Tree	*Xanthorrhoea fulva*		5			40	14	10	10	20	20	**12.0**
Bare Ground		0	0	0	0	0	0	0	0	0	0	**0**
Leaf litter		30.5	20	51	21.5	21.5	34.5	25.5	26	18.5	49.5	**29.85**
Timber (>/= 10cm)												
Total		**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100%**

Additional Species: *Hypolaena fastigiata, Schizaea dichotoma*

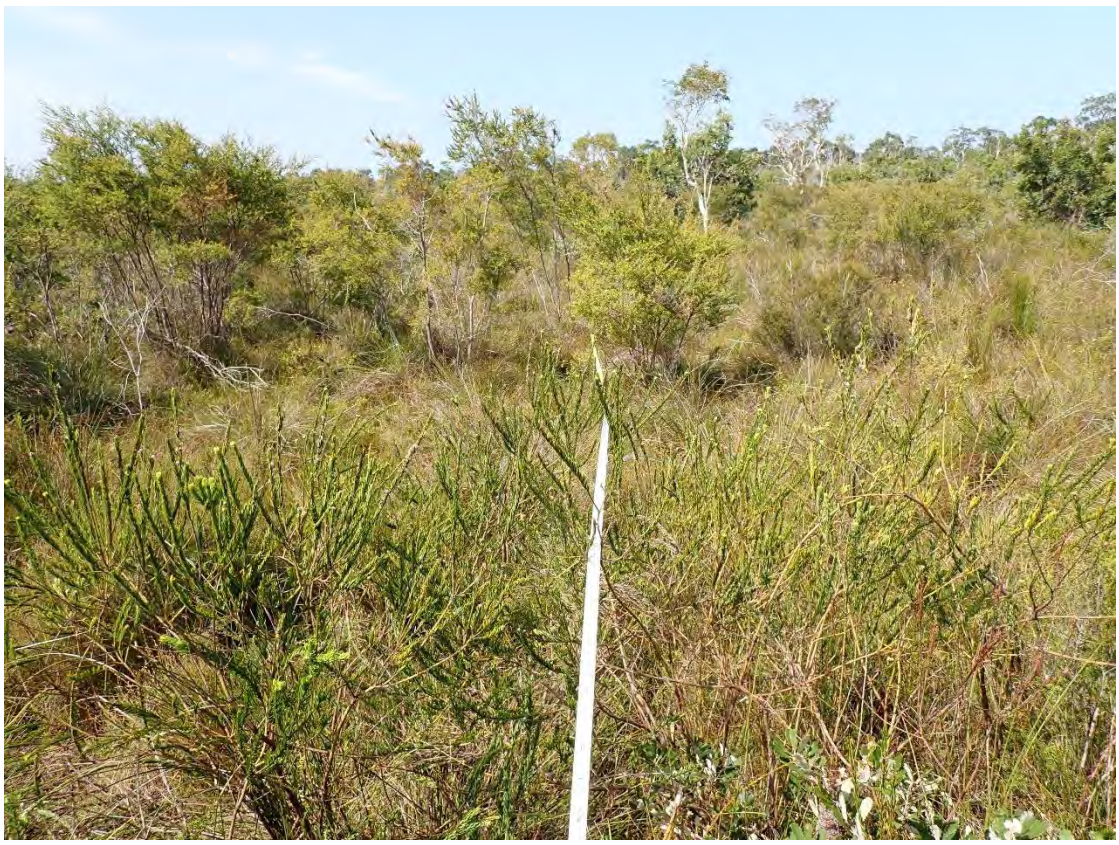
Structural / Floristic Summary

BioCondition Attribute		March 2024	October 2024
Native Plant Species Richness	Tree:	.	.
	Shrub:	15	17
	Grass Tree	1	1
	Grass / Sedge	6	6
	Forbs and other:	6	8
Total Species No**		**28/32**	
Native Shrubs	Projected Canopy Cover – Shrubs > 1m (%)	18.8	20.8
	Projected Canopy Cover – Shrubs >0.5 to <1m (%)	3.5	2.5
Native Ground cover (%):	Native perennial grass / sedge cover (%):	40.95	42.9
	Native shrubs (%)	25.6	13.6
	Grass tree	11.5	12.0
	Organic litter cover (%):	20.35	29.85
	Native forb cover (%)	2.1	1.65
Coarse woody debris:	Total length (m) of debris ≥ 10cm diameter and ≥0.5m in length per hectare	0	0
Non-native plant cover	Non-native Grasses%	0	0
	Non-native shrubs %	0	0

****Excludes Exotic Species**

Plot 6c – Centre to Start: March 2024 (Above) and October 2024 (Below).

Plot 6c Centre to End – March 2024 (Above) and October 2024 (Below)..



Plot 6c – Centre to North: March 2024 (Above) and October 2024 (Below).

Plot 6c – Centre to South: March 2024 (Above) and October 2024 (Below).

Appendix B – Shrub Stem Counts per Survey Event

Month	Site	Survey Effort	*Persoonia virgata*	*Banksia aemula*	*Banksia oblongifolia*	*Epacris pulchella*	*Leptospermum liversidgei*	*Leptospermum*	*Boronia falcifolia*	*Sprengelia sprengelioide*	*Leucopogon leptospermoi*	*Baeckea frutescens*	*Dilwynnia floribunda*	*Epacris obtusifolia*	*Olax retusa*	*Phyllota phylicoides*	*Leptospermum*	*Aotus lanigera*	*Strangea linearis*	*Conospermum taxifolium*	*Elaeocarpus reticulatus*	*Melaleuca quinquenervi*	*Pultenaea palacea*	*Agiortia pedicellata*	**Total Stem Counts**
Apr-16	Site 6	Event 1	93	2	86	13	125	6	97	26	15	60	8	13	3	12	9	2	0	0	1	2	0	0	**573**
Sep-16	Site 6	Event 2	91	2	50	4	101	0	103	3	17	31	3	11	0	0	8	2	1	1	1	3	0	0	**432**
Apr-17	Site 6	Event 3	87	2	41	2	75	0	43	1	9	23	3	0	0	0	6	10	0	0	1	2	0	0	**305**
Sep-17	Site 6	Event 4	95	2	41	1	64	0	87	0	8	19	0	1	0	1	9	8	0	0	1	1	0	0	**338**
Apr-18	Site 6	Event 5	99	3	43	0	76	0	62	5	10	33	5	2	0	19	9	2	0	0	1	2	0	0	**371**
Sep-18	Site 6	Event 6	81	3	22	8	58	0	50	6	8	14	0	2	0	0	3	10	0	0	1	3	0	2	**271**
Apr-19	Site 6	Event 7	85	3	34	0	42	2	39	0	6	26	2	0	0	10	17	0	0	0	3	2	0	3	**274**
Sep-19	Site 6	Event 8	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
Apr-20	Site 6	Event 9	0	1	20	0	9	0	0	0	0	19	0	0	0	0	0	0	0	0	1	0	0	0	**50**
Nov-20	Site 6	Event 10	0	2	34	0	3	0	0	0	1	52	0	0	0	49	10	0	0	0	1	2	0	0	**154**
Apr-21	Site 6	Event 11	0	2	26	0	5	4	0	0	4	42	0	0	0	125	12	0	0	0	0	0	0	0	**220**
Sep-21	Site 6	Event 12	0	2	50	0	0	16	17	0	13	58	0	0	0	393	8	0	7	0	0	1	4	0	**569**
Apr-22	Site 6	Event 13	0	3	46	0	10	9	5	0	6	41	1	0	0	560	14	0	1	0	0	1	2	0	**699**
Oct-22	Site 6	Event 14	0	4	75	0	10	44	49	1	24	43	1	2	1	567	15	0	7	0	0	1	10	0	**854**
Mar-23	Site 6	Event 15	0	3	68	0	20	19	53	1	24	56	0	0	0	615	12	0	2	0	0	1	3	0	**877**
Sep-23	Site 6	Event 16	0	4	56	0	16	21	244	0	18	38	14	0	0	483	15	0	0	0	0	1	0	0	**910**
Mar-24	Site 6	Event 17	1	4	47	0	37	11	47	0	26	42	14	1	0	601	6	2	13	0	0	2	6	0	**860**
Oct-24	Site 6	Event 18	0	4	38	17	31	11	23	0	39	61	0	0	0	557	8	0	10	0	0	1	2	0	**802**

Month	Site	Survey Effort	Persoonia virgata	Agiortia pedicellata	Leucopogon leptospermoides	Ochrosperma lineare	Boronia falcifolia	Leptospermum semibaccatu	Dylwynnia floribunda	Sprengelia sprengelioide	Strangea linearis	Acacia flavescens	Epacris pulchella	Baeckea frutescens	Aotus lanigera	Xanthorhoea johnsonii	Leptospermum polygalifoliu	Homoranthus virgatus	Melaleuca quinquenervi	Melaleuca pachyphylla	Total Stems
Apr-16	Site 5	Event 1	124	0	32	6	6	14	2	1	6	1	3	4	1	3	0	0	0	0	**203**
Sep-16	Site 5	Event 2	129	0	17	0	5	10	1	0	3	1	3	1	0	1	0	0	0	0	**171**
Apr-17	Site 5	Event 3	137	4	19	0	1	4	3	0	5	1	0	1	0	1	0	0	0	0	**176**
Sep-17	Site 5	Event 4	119	2	27	1	1	13	0	0	4	1	2	1	0	1	1	2	0	0	**175**
Apr-18	Site 5	Event 5	119	9	24	0	1	18	4	0	2	1	0	7	0	1	3	0	1	1	**191**
Sep-18	Site 5	Event 6	111	7	16	0	0	9	0	0	0	1	0	1	0	1	3	0	0	1	**150**
Apr-19	Site 5	Event 7	47	6	16	0	0	18	0	0	1	1	1	3	0	2	4	0	1	1	**101**
Sep-19	Site 5	Event 8	24	10	12	0	0	16	0	0	1	1	0	2	0	2	2	0	1	1	**72**
Apr-20	Site 5	Event 9	11	14	11	0	0	14	0	0	2	1	1	5	0	1	1	0	1	0	**62**
Nov-20	Site 5	Event 10	8	12	7	0	0	6	0	0	2	1	0	5	0	1	3	0	1	0	**46**
Apr-21	Site 5	Event 11	3	9	9	0	0	15	0	0	1	1	0	6	0	1	6	0	1	1	**53**
Sep-21	Site 5	Event 12	1	9	6	2	0	14	0	0	2	1	0	1	0	1	6	0	1	1	**45**
Apr-22	Site 5	Event 13	3	14	8	2	0	29	1	0	2	1	0	7	0	1	11	0	5	1	**85**
Oct-22	Site 5	Event 14	1	14	10	2	2	69	0	0	6	1	0	16	0	1	10	9	2	3	**146**
Mar-23	Site 5	Event 15	2	10	13	0	2	78	1	0	3	1	0	15	0	3	6	6	5	1	**146**
Sep-23	Site 5	Event 16	2	11	6	0	4	60	0	0	0	1	0	3	0	3	7	2	5	1	**105**
Mar-24		Event 17	1	12	10	0	1	46	1	0	3	1	0	6	0	1	8	5	2	2	**99**
Oct-24		Event 18	1	18	8	0	3	39	0	0	1	1	0	3	0	1	9	1	2	2	**89**

Appendix C – Pearson Correlation Analysis for Stem Counts, CRD and Species Richness

IP5_Pearson Corellation

	CRD vs. Persoonia virgata	CRD vs. Agiortia pedicellata	CRD vs. Leucopogon leptospermo	CRD vs. Ochrosperma lineare	CRD vs. Boronia falcifolia	CRD vs. Leptospermum semibacc	CRD vs. Dylwynnia floribunda	CRD vs. Sprengelia sprengelioide	CRD vs. Strangea linearis	CRD vs. Acacia flavescens	CRD vs. Epacris pulchella	CRD vs. Baeckea frutescens	CRD vs. Aotus lanigera	CRD vs. Xanthorhoea johnsonii	CRD vs. Leptospermum polygalif	CRD vs. Homoranthus virgatus	CRD vs. Melaleuca quinquenervia	CRD vs. Melaleuca pachyphylla	CRD vs. Total Stems
Pearson r																			
r	-0.2538	0.3472	-0.1461	0.1829	0.4153	0.7661	0.04027	0.02741	0.3666	0.4031	-0.06150	0.5692	0.02741	0.01306	0.6711	0.7035	0.5670	0.6193	0.2558
95% confidence interval	-0.6443 to 0.2417	-0.1428 to 0.7005	-0.5739 to 0.3442	-0.3104 to 0.5987	-0.06394 to 0.7389	0.4659 to 0.9082	-0.4348 to 0.4978	-0.4452 to 0.4880	-0.1210 to 0.7117	-0.07861 to 0.7322	-0.5136 to 0.4174	0.1394 to 0.8186	-0.4452 to 0.4880	-0.4566 to 0.4770	0.2975 to 0.8665	0.3523 to 0.8810	0.1362 to 0.8175	0.2144 to 0.8426	-0.2397 to 0.6456
R squared	0.06440	0.1206	0.02136	0.03347	0.1725	0.5869	0.001622	0.0007516	0.1344	0.1625	0.003783	0.3240	0.0007516	0.0001705	0.4504	0.4949	0.3215	0.3835	0.06544
P value																			
P (two-tailed)	0.3096	0.1580	0.5628	0.4675	0.0865	0.0002	0.8739	0.9140	0.1346	0.0972	0.8084	0.0137	0.9140	0.9590	0.0023	0.0011	0.0141	0.0061	0.3056
P value summary	ns	ns	ns	ns	ns	***	ns	ns	ns	ns	ns	*	ns	ns	**	**	*	**	ns
Significant? (alpha = 0.05)	No	No	No	No	No	Yes	No	No	No	No	No	Yes	No	No	Yes	Yes	Yes	Yes	No
Number of XY Pairs	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18

IP6_Pearson Corellation

	CRD vs. Persoonia virgata	CRD vs. Banksia aemula	CRD vs. Banksia oblongifolia	CRD vs. Epacris pulchella	CRD vs. Leptospermum liversidgei	CRD vs. Leptospermum semibaccatu	CRD vs. Boronia falcifolia	CRD vs. Sprengelia sprengelioides	CRD vs. Leucopogon leptospermoide	CRD vs. Baeckea frutescens	CRD vs. Dilwynnia floribunda	CRD vs. Epacris obtusifolia	CRD vs. Olax retusa	CRDvs. Phyllota phyllicoides	CRD vs. Leptospermum polygalifoliu	CRD vs. Aotus lanigera	CRD vs. Strangea linearis	CRD vs. Conospermum taxifolium	CRD vs. Eleaocarpus reticulatus	CRD vs. Melaleuca quinquenervia	CRD vs. Pultenaea palacea	CRD vs. Agiortia pedicellata	CRD vs. Total Stem Counts
Pearson r																							
r	-0.2551	0.7631	0.6157	0.2277	0.02958	0.6835	0.2851	0.005940	0.7894	0.4455	0.4368	0.1137	0.1774	0.7988	0.3980	-0.1724	0.5775	0.06793	-0.4677	0.04810	0.6556	-0.2842	0.8803
95% confidence interval	-0.6451 to 0.2404	0.4601 to 0.9069	0.2088 to 0.8409	-0.2676 to 0.6278	-0.4434 to 0.4897	0.3182 to 0.8721	-0.2096 to 0.6637	-0.4622 to 0.4715	0.5107 to 0.9180	-0.02700 to 0.7553	-0.03780 to 0.7506	-0.3730 to 0.5513	-0.3156 to 0.5950	0.5294 to 0.9219	-0.08460 to 0.7293	-0.5916 to 0.3203	0.1515 to 0.8226	-0.4120 to 0.5184	-0.7671 to -0.001031	-0.4284 to 0.5037	0.2719 to 0.8594	-0.6631 to 0.2106	0.7020 to 0.9548
R squared	0.06508	0.5823	0.3791	0.05184	0.000874 7	0.4672	0.08130	3.529e-005	0.6231	0.1985	0.1908	0.01292	0.03148	0.6381	0.1584	0.02971	0.3335	0.004615	0.2187	0.002314	0.4298	0.08076	0.7750
P value																							
P (two-tailed)	0.3069	0.0002	0.0065	0.3635	0.9073	0.0018	0.2514	0.9813	<0.0001	0.0639	0.0699	0.6533	0.4812	<0.0001	0.1019	0.4940	0.0121	0.7888	0.0503	0.8497	0.0031	0.2531	<0.0001
P value summary	ns	***	**	ns	ns	**	ns	ns	****	ns	ns	ns	ns	****	ns	ns	*	ns	ns	ns	**	ns	****
Significant? (alpha = 0.05)	No	Yes	Yes	No	No	Yes	No	No	Yes	No	No	No	No	Yes	No	No	Yes	No	No	No	Yes	No	Yes
Number of XY Pairs	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18

Correlation between CRD and Species Richness

	Species Richness IP6	Species Richness CP5
Best-fit values		
Slope	0.007836	0.007429
Y-intercept	33.41	35.53
X-intercept	-4264	-4783
1/slope	127.6	134.6
Std. Error		
Slope	0.004446	0.002232
Y-intercept	2.701	1.356
95% Confidence Intervals		
Slope	-0.001589 to 0.01726	0.002697 to 0.01216
Y-intercept	27.68 to 39.14	32.66 to 38.41
X-intercept	-infinity to -1674	-13954 to -2741
Goodness of Fit		
R squared	0.1626	0.4091
Sy.x	7.966	4.000
Is slope significantly non-zero?		
F	3.106	11.08
DFn, DFd	1, 16	1, 16
P value	0.0971	0.0043
Deviation from zero?	Not Significant	Significant
Equation	Y = 0.007836*X + 33.41	Y = 0.007429*X + 35.53
Data		
Number of X values	18	18
Maximum number of Y replicates	1	1
Total number of values	18	18
Number of missing values	0	0

Appendix D – Site / Species Table

Habit	General Fire Response	Family	Species	Site 6_Presence / Absence Sept 2024	Site 6_Presence / Absence March 2024	Site 5_Presence / Absence Oct 2024	Site 5_Presence / Absence March 2024
Forb	Obligate Seeder	Droseraceae	*Drosera binata*	*0*	*1*	*0*	*1*
Forb	Resprouter	Colchicaceae	*Burchardia umbellata*	*1*	*0*	*0*	*1*
Forb	Obligate Seeder	Haloragaceae	*Gonocarpus micranthus*	*1*	*0*	*0*	*1*
Forb	Resprouter	Orchidaceae	*Cryptostylis erecta*	*1*	*0*	*0*	*1*
Forb	Resprouter	Iridaceae	*Patersonia sericea (fragilis)*	*1*	*1*	*1*	*1*
Forb	Resprouter	Thymeleaceae	*Pimelea linifolia*	*1*	*1*	*1*	*1*
Forb	Obligate Seeder	Lauraceae	*Cassytha glabella*	*1*	*1*	*1*	*1*
Forb	Obligate Seeder	Dilleniaceae	*Hibbertia salicifolia*	*1*	*1*	*1*	*1*
Forb	Obligate Seeder	Picrodendraceae	*Pseudanthus orientalis*	*1*	*1*	*1*	*1*
Forb	Resprouter	Blechnaceae	*Blechnum cartiligineum*	*0*	*0*	*1*	*1*
Forb	Resprouter	Loganiaceae	*Mitrasacme alsinoides*	*0*	*0*	*1*	*1*
Forb	Resprouter	Xyridaceae	*Xyris complanata*	*1*	*0*	*1*	*1*
Grass	Resprouter	Poaceae	*Eriachne pallescens var. gracillis*	*0*	*0*	*1*	*1*
Grass tree	Resprouter	Xanthorrhoeaceae	*Xanthorrhoea fulva*	*1*	*1*	*1*	*1*
Grass tree	Resprouter	Xanthorrhoeaceae	*Xanthorrhoea johnsonii*	*0*	*0*	*1*	*1*
Sedge / Rush	Resprouter	Restionaceae	*Baloskion tenuiculme*	*1*	*1*	*1*	*1*
Sedge / Rush	Resprouter	Restionaceae	*Caustis recurvata*	*1*	*1*	*1*	*1*
Sedge / Rush	Resprouter	Laxmanniaceae	*Lomandra elongata*	*1*	*1*	*1*	*1*
Sedge / Rush	Resprouter	Restionaceae	*Sporodanthus interuptus*	*1*	*1*	*1*	*1*
Sedge / Rush	Resprouter	Laxmanniaceae	*Lomandra longifolia*	*1*	*1*	*1*	*1*
Sedge / Rush	Resprouter	Cyperaceae	*Hypolaena fastigiata*	*1*	*1*	*1*	*1*
Sedge / Rush	Resprouter	Cyperaceae	*Gahnia seiberiana*	*0*	*0*	*1*	*1*
Shrub	Resprouter	Myrtaceae	*Baeckea imbricata*	*1*	*1*	*0*	*1*
Shrub	Obligate Seeder	Proteaceae	*Persoonia virgata*	*1*	*1*	*1*	*1*

Habit	General Fire Response	Family	Species	Site 6_Presence / Absence Sept 2024	Site 6_Presence / Absence March 2024	Site 5_Presence / Absence Oct 2024	Site 5_Presence / Absence March 2024
Shrub	Resprouter	Myrtaceae	*Baeckea frutescens*	1	1	1	1
Shrub	Obligate Seeder	Myrtaceae	*Homoranthus virgatus*	1	1	1	1
Shrub	Resprouter	Myrtaceae	*Leptospermum semibaccatum*	1	1	1	1
Shrub	Resprouter	Ericaceae	*Leucopogon leptospermoides*	1	1	1	1
Shrub	Obligate Seeder	Myrtaceae	*Ochrosperma lineare*	1	1	1	1
Shrub	Obligate Seeder	Proteaceae	*Strangea linearis*	1	1	1	1
Shrub	Resprouter	Rutaceae	*Boronia falcifolia*	1	1	1	1
Shrub	Obligate Seeder	Fabaceae	*Dillwynia floribunda*	1	1	1	1
Shrub	Obligate Seeder	Ericaceae	*Epacris obtusifolia*	1	1	1	1
Shrub	Obligate Seeder	Ericaceae	*Sprengelia sprengelioides*	1	1	1	1
Shrub	Resprouter	Myrtaceae	*Leptospermum polygalifolium*	1	1	1	1
Shrub	Resprouter	Proteaceae	*Banksia aemula*	1	1	1	1
Shrub	Resprouter	Myrtaceae	*Melaleuca quinquenervia*	1	1	1	1
Shrub	Resprouter	Ericaceae	*Agiortia pedicellata*	0	0	1	1
Shrub	Obligate Seeder	Mimosaceae	*Acacia baueri*	0	0	1	1
Shrub	Obligate Seeder	Mimosaceae	*Acacia flavescens*	0	0	1	1
Shrub	Obligate Seeder	Myrtaceae	*Melaleuca pachyphylla*	0	0	1	1
Forb	Resprouter	Selaginellaceae	*Selaginella uliginosa*	1	1	0	0
Forb	Resprouter	Polygalaceae	*Comesperma sphaerocarpum*	0	0	0	0
Forb	Obligate Seeder	Dilleniaceae	*Hibbertia acicularis*	0	0	0	0
Forb	Resprouter	Orchidaceae	*Microtus parviflora*	0	0	0	0
Forb	Resprouter	Laxmanniaceae	*Sowerbaea juncea*	0	0	0	0
Forb	Resprouter	Stylidiaceae	*Stylidium trichopodom*	0	0	0	0
Forb	Resprouter	Schizaeaceae	*Schizaea dichotoma*	1	0	0	0
Forb	Resprouter	Stackhousiaceae	*Stackhousia nuda*	1	0	0	0
Forb	Obligate Seeder	Fabaceae	*Mirbellia rubiifolia*	0	1	1	0
Forb	Obligate Seeder	Laxmanniaceae	*Laxmannia compacta*	0	0	1	0
Grass	Resprouter	Poaceae	*Themeda triandra*	0	0	0	0

Habit	General Fire Response	Family	Species	Site 6_Presence / Absence Sept 2024	Site 6_Presence / Absence March 2024	Site 5_Presence / Absence Oct 2024	Site 5_Presence / Absence March 2024
Sedge / Rush	Resprouter	Cyperaceae	*Schoenus scabripes*	*0*	*1*	*0*	*0*
Sedge / Rush	Resprouter	Restionaceae	*Baloskion heterophylla*	*0*	*0*	*0*	*0*
Sedge / Rush	Resprouter	Cyperaceae	*Cyperus sp. (gracilis?)*	*0*	*0*	*0*	*0*
Sedge / Rush	Resprouter	Restionaceae	*Leptocarpus tenax*	*0*	*0*	*0*	*0*
Sedge / Rush	Resprouter	Cyperaceae	*Schoenus calostachys*	*0*	*0*	*0*	*0*
Shrub	Resprouter	Proteaceae	*Banksia oblongifolia*	*1*	*1*	*0*	*0*
Shrub	Resprouter	Myrtaceae	*Leptospermum liversidgei*	*1*	*1*	*0*	*0*
Shrub	Obligate Seeder	Fabaceae	*Phyllota phylicioides*	*1*	*1*	*0*	*0*
Shrub	Obligate Seeder	Fabaceae	*Pultenaea paleacea*	*1*	*1*	*0*	*0*
Shrub	Obligate Seeder	Fabaceae	*Aotus lanigera*	*1*	*1*	*0*	*0*
Shrub	Obligate Seeder	Fabaceae	*Pultenaea robusta*	*1*	*1*	*0*	*0*
Shrub	Obligate Seeder	Ericaceae	*Epacris pulchella*	*0*	*0*	*0*	*0*
Shrub	Resprouter	Myrtaceae	*Austromyrtus dulcis*	*0*	*0*	*0*	*0*
Shrub	Resprouter	Proteaceae	*Conospermum taxifolium*	*0*	*0*	*0*	*0*
Shrub	Resprouter	Olacaceae	*Olax retusa*	*1*	*0*	*0*	*0*
Tree	Resprouter	Elaeocarpaceae	*Elaeocarpus reticulatus*	*0*	*0*	*0*	*0*
Forb	Resprouter	Goodeniaceae	*Goodenia stelligera*	*1*	*0*		

? indicates a low level of confidence on regeneration strategies.

Appendix B – Peer Review

Refer to the *Peer Review* below from Paul Williams (Principal Hydrogeologist; Paul Williams & Associates Pty Ltd) on 25/11/2025 of the *Bribie Island Borefield Groundwater Dependent Ecosystems: Annual Vegetation Monitoring Report 2024* by 3D Environmental.

Peer Review of Bribie Island Borefield Groundwater Dependent Ecosystems - Annual Vegetation Monitoring Report – 2024, by 3D Environmental

Overview

The long term Bribie island heath monitoring provides a really valuable database with fire and soil moisture implications for a broad area of coastal south east Queensland.

This 2024 survey and report provide important information, including the now 5 years post-fire vegetation condition in the IPs, and the influence of a wet 2024. This will need to be taken into consideration if any water extraction is planned.

This report is well written, the data is well summarised, the statistics are valid and the conclusions are supported by the data.

I have added suggestions to a version of the report with “tracked changes”.

Specific comments

Results Section:

A key interesting result is that the cover of shrubs (>1m) has plateaued even though 2024 was a wet year. Overall stem counts have declined slightly, although it is good to see a list of species with significantly increased stems.

Discussion & Summary:

The variations of species richness, increasing in IPs but declining in CPs is interesting, and covered well, with the possibility of a delayed fire response.

Have you observed when Phyllota plants (or other obligate seeders) started flowering or seeding - e.g. 4 - 5 years after fire? It is interesting that Phyllotta is not yet declining significantly in density.

Yours sincerely,

Paul Williams

25 November 2024